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Department of Education
English Program Services

Science Safety Guidelines

Grades Primary–12

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Science Safety Guidelines
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Disclaimer

The information and materials in these guidelines have been compiled from sources believed to be reliable and to represent the best current opinions on the subject in order to provide basic safety guidelines to be followed in Nova Scotia schools. These guidelines are intended to serve as a starting point for good practices and do not purport to specify minimum legal standards. No warranty, guarantee, or representation is made by the Department of Education as to the accuracy or sufficiency of the information contained herein. These guidelines are intended to provide basic information regarding safe practices. Therefore, it cannot be assumed that all necessary warning and precautionary measures are included in these guidelines and that other or additional measures may not be required.

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Introduction

Background

A major concern of science educators today is how to provide students with the exposure to laboratory activities while maintaining a safe learning environment. The information in this manual is intended to help educators provide a complete science safety program that supports an exciting and meaningful science curriculum and reduces the risk of injury to staff and students.

Teachers should be constantly alert to potential dangers. Common sense can go a long way toward maintaining a safe environment. Some risk is inherent in almost all science activities and to minimize these risks the following factors have to be considered:

- ability of teaching personnel to ensure a safe program
- support from administrators in promoting safety
- knowledge of subject matter and of chemicals and equipment used
- assurance of cooperation from students who have been taught their responsibilities in the labs

Not all hazardous materials can be eliminated from the program—nor would we want them eliminated if we are to provide a meaningful science curriculum. Yet some of our schools are unable to provide the conditions necessary for the safe use of all chemicals in their laboratories. The decision to use certain substances in the school laboratory should be based on the best available knowledge of each chemical's particular hazard and the availability of proper handling facilities. When the risk outweighs the benefit and no substitute is available, then the experiment should be eliminated from the program.

Accidents do not just happen—they are caused. If the potential cause can be detected and eliminated, fewer accidents should happen. Accidents can be prevented by

- an educational safety program
- proper supervision of students
- instruction in appropriate laboratory techniques
- good laboratory housekeeping

Science teachers who have been alerted to the hazards in the labs, who have provided a student educational safety program, and who promote sound laboratory techniques are in a better position to ensure a safe and successful science program.

Responsibilities

Encouraging a positive safety attitude is a shared responsibility among the following four main groups:

- school boards and superintendents
- school administration
- science teachers
- students

The co-operation of all these groups helps to develop a strong safety consciousness both inside and outside our schools.

Responsibilities of School Board and Superintendent

The school board and superintendent have a responsibility to

- ensure that schools comply with safety regulations
- provide in-service education so that staff may increase their knowledge of safety measures in order to provide a safe working and learning environment
- provide facilities that ensure the safety of all students including students with disabilities
- initiate planning for the necessary improvements and procedures that ensure science safety

Responsibilities of School Administration

School administrators have the responsibility to

- ensure that safety practices are being followed in their schools
- ensure that science laboratory activities are being taught and supervised only by teachers with the required expertise to teach such activities safely
- ensure that substitute teachers not be required to supervise laboratory activities unless they are familiar with the students, the specific topic of study, and safety requirements
- support in-service education to improve the safety knowledge of teachers, including training in first aid, cardiopulmonary resuscitation (CPR), and Workplace Hazardous Materials Information System (WHMIS)
- enforce disciplinary measures if safety guidelines are not being followed
- ensure that science classes be of an appropriate size to allow teachers to adequately supervise laboratory activities
- ensure that science laboratory enrolment does not exceed the capacity of the available lab stations based on the Department of Education building guidelines

- provide teachers with the necessary resources and equipment that will ensure safety in the laboratory, including a copy of these guidelines
- make provisions for the safety of students with disabilities as well as for those with cultural or language difficulties
- carry out routine safety inspections and identify problems to be rectified, where possible at the school level
- direct any safety concerns that cannot be corrected at the school level to the appropriate district personnel

Responsibilities of the Science Teacher

Teachers have the responsibility to

- provide for the safety of their students
- be able to reasonably anticipate the potential problems and hazards associated with an activity and to take reasonable precautions to prevent foreseeable accidents
- instruct students in the proper and safe way to carry out science lab activities and supervise their students to see that their instructions are followed
- provide opportunity for students to practise safety procedures at the start of the course. This shall include, but not be limited to the following: emergency evacuation procedures, operation of eye-wash fountain/bottle, operation of the fire blanket and the Stop, Drop, and Roll method of extinguishing fire, and introduction to the WHMIS system
- provide for students a safety contract which should be signed by them and their parent or guardian, indicating that they have read, understood, and accepted their safety responsibilities (see Appendix F).
- enforce rules which will result in reasonable and sensible behaviour
- ensure, prior to the commencement of a particular laboratory activity, that students are aware of particular dangers and necessary actions
- ensure that equipment used in science laboratories is in safe working order and report, in writing, any faulty equipment or other hazards to the school administration
- not leave students unsupervised in the laboratory or storage area
- keep dated, written records of any accidents or injuries related to laboratory activities and report such incidents to the school administration immediately
- take note of students who have medical conditions such as epilepsy, asthma, or severe allergies and who may require special attention
- take an up-to-date first aid course and receive instruction in the Workplace Hazardous Materials Information System (WHMIS) as outlined in provincial and federal legislation
- provide a substitute teacher with a lesson plan for an activity that may be carried out safely

- follow the safety procedures in these guidelines
- not conduct a laboratory activity if he or she feels that safety is being compromised. Written notification must be provided to the principal and appropriate program specialists/consultants stating the specific safety concerns and the actions required to correct the problem.

Responsibilities of Science Students

Science students have a responsibility to

- listen to and obey the instructions of the teacher in the science lab and behave safely and responsibly
- not perform any experimental activity in the lab without the expressed permission of the teacher or without the teacher's supervision
- report to the teacher immediately any dangerous situations or accidents

A student will be suspended from participating in current and future laboratory activities after refusal to follow acceptable laboratory practices or behaviours that create a dangerous situation for the student or other students.

Legal Aspects of Science Safety

The following points are not intended to provide comprehensive coverage of the law governing science safety. They are included to increase teacher awareness of some of the inherent risks in many activities, and to promote a questioning and cautious attitude.

Negligence may be defined as conduct that falls below a standard of care established by law to protect others against an unreasonable risk of harm. There are at least three major types of negligence:

- Malfeasance—doing that which should not have been done
- Misfeasance—improper performance of a lawful act
- Non-feasance—failure to do what should have been done

Guidelines to Safer Practices

- Teachers are expected to protect the health, welfare, and safety of their students
- Teachers are expected to be able to foresee the reasonable consequences of their actions and inactions. A reasonable person (teacher or administrator) is expected to be aware of the foibles of human nature (students) and be able to anticipate what difficulties might arise in terms of safety problems, typical, or atypical student behaviour. Ignorance is not an excuse in the eyes of justice.
- Careful planning is expected for all activities. The following questions can be used as a guide when planning an activity.
  - What are the hazards?
  - What are the worst case scenarios?
  - How can I prepare for the worst case scenario?
  - What practices, safety equipment, and protective facilities are prudent and appropriate?
- Teachers must carefully instruct their classes and must give careful directions.
- Teachers should create an environment in which appropriate laboratory behaviour is maintained.
- The teacher's presence is necessary to ensure adequate safety supervision.
- An environment in which appropriate laboratory behaviour is maintained must be created.
- Any hazardous or potentially hazardous conditions must be reported immediately to supervisory personnel. Reports should be written, and the teacher should retain a personal copy.
- Teachers should be aware of school board and provincial policies related to lab activities.

Safety in the classroom is of paramount importance. Other components of education—resources, teaching strategies, and facilities attain—their maximum utility only in a safe classroom or lab. Safety is no longer a matter of common sense. To create a safe environment requires that a teacher

- be informed by
  - being familiar with these guidelines
  - reading safety articles in teachers' journals
  - attending safety sessions at in-services or conventions
  - professional exchanging
- be aware by
  - developing awareness through a visible safety emphasis
  - having safety equipment prominently displayed
  - displaying safety posters on the wall such as commercial, teacher-made, or student-made safety posters
  - organizing a safety class with students at the beginning of the year and placing regular emphasis on safety precautions prior to an activity
- be proactive by
  - acting on what is known and on what he/she is aware of
  - modelling safe procedures at all times
  - instructing students regularly on safe procedures
  - closely supervising students at all times
  - being aware of students' health or allergy problems
  - taking a first-aid course

Elementary Years

Although experimentation in the elementary years may not be conducted in as much depth as in high school, and the equipment and chemicals may not be as sophisticated, the attention to safety is just as important. More detailed information may be found throughout these guidelines.

Safety is an important concern in the elementary science classroom because students are learning new skills and working with unfamiliar equipment and materials that can pose some degree of hazard. Safety in the elementary school science classroom depends upon the wise selection of experiments, materials, resources, and field experiences as well as consistent adherence to correct and safe techniques. It also requires thorough planning, careful management, and constant monitoring of students' activities. Teachers should be knowledgeable of the properties, possible hazards, and proper use and disposal of all materials used in the classroom. This information can be attained through the Material Safety Data Sheets (MSDS).

Chemical Hazards

Any household chemical brought in to the school should be treated with the same precautions as other chemicals.

Hazardous effects of all chemicals used improperly should be known.

The following household chemicals should **not** be used in school activities:

Chemical	Hazard
Bleach	• when mixed with acid, chlorine gas is produced • when mixed with another bleach and/or cleaner, harmful gas is produced
Drain Cleaner	• the substance is caustic (corrosive) • when mixed with water, extreme heat is produced • when mixed with another drain cleaner, could cause a violent reaction
Fine Powdered Substances	• should not be placed near a heat source as there is a danger of spontaneous combustion
Gasoline and other Fuels	• there is a danger of burning if near a flame
Products Containing Methanol	• there is a danger of burning

Biological Hazards

The following section includes biological hazards that elementary students are likely to encounter. If students do encounter these hazards, teachers should do the following:

- Inform the principal before bringing any animals in to the school.
- Do not allow students to handle animals without proper instruction and supervision.
- Find out any possible diseases of the animal you may be considering.
- All local, provincial, and federal guidelines regarding the care and treatment of animals should be followed.
- Animals must be kept in a clean, comfortable environment and given food and water regularly.
- Arrangements must be made to care for animals during times when the school is closed

Item	Hazard
Disease	• can be carried by animals—turtles can carry salmonella • can be spread by certain birds
Reputable Supplier	• rabies—all mammals must be inoculated against rabies • strays or wild animals are not allowed—they may carry diseases
Cleanliness	• Students must wash their hands before and after contact with animals.
Scratches and Bites	• Gloves should be worn to handle animals. • Obtain medical treatment if scratched or bitten.
Aquatic Animals	• Fish, mollusks, sea urchins, etc., can cause wounds, infections, or allergic reactions.

Other Hazards

Other Hazards	Precautions
Plants	• unless known to be safe, treat the plant as poisonous • do not allow students to put any part of a plant in or near their mouths • avoid contact with the juice or sap of plants; they can irritate the skin • wash hands after handling plants, especially before eating
Fire	• use extreme caution when using a flame • long hair must be tied back • loose clothing can be dangerous around a flame • melting wax and flame can cause serious burns • students should not have access to matches or other igniters
Earth and Space Science	• asbestos samples should not be used • viewing the sun during an eclipse should not be allowed at this level
Light and Sound	• students should not be exposed to extremely loud or continuous sounds • damage to the ear is irreversible and cumulative • direct exposure of eyes to bright lights can cause permanent damage • lasers can cause eye damage if the beam enters the eye; use only a low power laser if doing a demonstration • students shall not be permitted to use laser pointers or pens
Machines	• simple machines and other moving objects can catch loose clothing, catch hair, and pinch fingers • belts, pulleys, levers, hand mixers, etc., should not be used by students without adult supervision

Junior and Senior High School

No matter what age level, safety is a primary concern in the classroom. While elementary students are just becoming familiar with handling chemicals and equipment, junior high students have already had between 6–9 years experience in these areas. As students become older, more opportunity is given to them to work with more sophisticated apparatus and chemicals.

While the same guidelines, cautions, and recommendations apply as were given for the elementary students, the following additional notes are provided for junior and senior high students.

Chemistry, of all the sciences, poses the most problems for safety. Consequently, all chemistry teachers are urged to consider the hazards, minimize them as much as possible, and train students to work safely. A laboratory period on safety precautions and procedures to be used in the event of an accident should begin the year. This is the time to allay the fears of those students who find laboratory work threatening. The attitude that students should have is a respect for the laboratory, with the realization that they must understand the procedures, learn the required techniques, and approach experiments seriously. They should be assured that all experiments are safe under these conditions. Safety precautions for each laboratory experiment should be noted just before students are to begin it. An opportunity should be provided for students to ask questions about procedures or techniques involved.

Chemical	Hazard
Preparation of H_2	• must be done only by an experienced science teacher • in a well ventilated room • no open flames
Acids	• corrosive • know the correct procedures for dilution and clean-up of spills • dilution of HCl should be done in a fume hood; vapours are toxic • always add acid to water
Bases	• can be more corrosive than acids • KOH and NaOH pellets must be kept in a tightly sealed bottle • NH_4OH greater than 3 M must be used in a fume hood

Biological Hazards

School boards and their agents, classroom teachers, have an obligation to ensure their classrooms are free from hazardous materials that might endanger students, other workers, and visitors. In laboratory exercises and demonstrations involving cells, tissues, or organisms, it is impossible to guarantee an absolutely sterile environment for all students and teachers at all times. It is, then, wise to prohibit the use of potentially dangerous biological materials during laboratory work and demonstrations done in the classroom. This is particularly important because some infectious organisms have been found to survive long periods of drying.

Concerns have been raised by the Canadian medical community regarding the handling of mammalian tissues, partially in response to the emergence of pathogens such as the virus that causes Acquired Immune Deficiency Syndrome (AIDS). AIDS and other diseases such as hepatitis, which are transmitted through direct cellular contact by intrusion of foreign fluids, have been diagnosed in large numbers throughout the world.

The education value of investigations such as blood sampling or cheek cell scrapes cannot justify the increased health risk of these and other related procedures to students and staff. The Nova Scotia Department of Education firmly believes that the health and well-being of all members of the education community must be a prime consideration in selecting learning activities.

Item	Precaution
Handling micro-organisms	• avoid bacteria, fungi, etc., known to be pathogenic • cultures should be grown at room temperature • clean and disinfect all work surfaces before and after handling micro-organisms • do not culture anaerobic bacteria, soil bacteria, or swabs from any surface which may contain micro-organisms from a human source • petrie dishes containing cultures should be sterilized before disposal • transparent tape should be used to seal petrie dishes before they are passed around the class • avoid spattering cultures to prevent aerosol formation which is a common means of infection • flame wire loops and needles before and immediately after transfer of cultures • do not move throughout the lab with a wire loop containing a culture

Item	Precaution
Dissections	• do not dissect wild or stray animals found dead outside • any organs used should be federally and provincially inspected • use dissecting instruments with care; make sure they are rust free and clean • cut down and away • formaldehyde(for preserving specimens) is not allowed in schools; instead use a 70% solution of ethanol in water • students should use disposable gloves • wash hands before and after dissection • use a wax or Styrofoam pan to dissect; never dissect in your hands
Plants	• handle with care • treat it as though it were poisonous • do not allow students to put any part in or near their mouths • avoid skin contact with the juice or sap of plants • wash hands after handling plants and before eating

Fire

There are three aspects to this topic: prevention, evacuation, and control. Prevention means eliminating or keeping very close control over flammable or potentially explosive materials in science laboratories. This involves procedures for handling storage, spills, disposal, and training students to use dangerous materials safely. Prevention is obviously the most important aspect for teachers.

In the event of a fire, the evacuation of students is the first consideration. Fire drills are mandatory, and each student must know the planned route and alternate route if the original is blocked. All science laboratories must have two exits that are clearly labelled with exit signs. The need for orderly evacuation should be stressed in the event that the route needs to be changed and the direction from the P.A. system or by other means have to be heard.

When students are safely out of the area and the alarm has been given, fire control should be considered. There are three factors that are required before a fire can begin: a source of flammable material, an oxidizing agent (usually air), and sufficient heat to cause the material to ignite. Fire control is directed towards the elimination of one, two, or all three of these factors. Although there are limited possibilities for removing burning material once it has been ignited, one source of flammable material can be eliminated if the master valve for the propane gas is clearly marked and shut off in the event of a fire. The second and third factors, air and the source of heat, can be controlled by the use of fire extinguishers or fire blankets. The location of these items should be clearly marked, and all teachers and students should be trained in their use.

Classes of Fire and Appropriate Fire Extinguishers

Class A fires include burning of wood, textiles, paper, and other solid combustibles. This type of fire is extinguished by cooling with water or dry chemical or carbon dioxide fire extinguishers.

Class B includes fires in gasoline, oil, paint, or other flammable liquids that gasify when heated. These fires cannot be extinguished with water since they float on the water and are merely spread if water is added to them. Carbon dioxide, dry chemical, or foam extinguishers are effective for this type of fire. Teachers and students must be familiar with these extinguishers and how they are to be used.

Class C fires are those in live electrical equipment. This type of fire must be extinguished by using a conductive agent. A carbon dioxide extinguisher smothers the flame without damaging the equipment. A dry chemical extinguisher is also effective. Whenever possible, the source of power to the burning equipment should be turned off.

Class D fires are not common in science since they involve the combustion of such metals as magnesium, potassium, zirconium, and sodium. A special extinguisher powder, unlike regular dry chemical, may be applied or dry sand may be used.

Teaching students the type of fires and how they may be extinguished is not only essential to safety but also an excellent science lesson. It should be noted that one of the three factors must be removed to extinguish a fire. The material may be cooled below its ignition point (for example, with water) or the available air can be removed with a heavy gas such as carbon dioxide or with the use of foam. While there are various types of fire extinguishers, the most popular is the carbon dioxide type since it is useful for fires of Class A, B, or C. Fire extinguishers are only useful on fires at very early stages. Consequently, they should be mounted in a conspicuous place near the exit so that the operator can easily retreat should conditions warrant it. Teachers must, and students should, know how to operate fire extinguishers efficiently and safely. Extinguishers must be in good operating condition when fire strikes and, therefore, must be maintained and recharged by competent personnel on a regular basis and after use. Halon extinguishers are among the newest types available. They are useful on Class A, B, and C fires and provide a nontoxic, noncorrosive substance that smothers the flame. They are quite expensive, so they should not be used for demonstration purposes. Carbon dioxide extinguishers are the safest, cleanest, and cheapest to use for safety demonstrations.

Hazard	Precaution
Using a Bunsen Burner	• tie hair back • avoid loose clothing • remove baseball caps with protruding brims • do not use matches or butane lighters for lighting a Bunsen burner
Flammable and Combustible Liquids	• be aware of the flashpoint of the liquids in use – flammable liquids—the flashpoint is below 37.8° C – combustible liquids—flashpoint is between 37.8° C and 93.3° C – refer to the appendix for information on the flammability of substances • keep away from open flames and other heat sources • quantities in use should be kept to a minimum • adequate ventilation must be used • alcohol lamps, if used, **must not** be glass ones
Gases	• flammable gases such as hydrogen, methane, and propane may form explosive mixtures with air at relatively low concentrations • when H_2 is collected for testing , ensure only small (e.g., test tube) quantities are ignited • when using H_2, ensure adequate ventilation • non-flammable gases such as nitrogen, when stored under pressure in steel containers, may explode when heated by an existing fire
Solids	• aluminum, iron, or zinc in the form of fine powders may present a fire hazard • white phosphorus and potassium are prohibited in school laboratories
Reactions	• highly exothermic reactions may produce enough energy to start a fire if flammable or combustible substances are present • be aware of all fire risks and take adequate precautions when carrying out any demonstration which is not part of the core curriculum • do not allow students to mix any chemicals except as part of an authorized lab activity or under the supervision of a teacher
Electrical Fires	• caused when too large a current is passed through electrical equipment or wiring causing it to overheat

Electrical Hazards

Item	Hazard
Voltage	• no experiments performed at greater than 30 V • use fuses or circuit breakers • insulate live parts of circuits • clearly identify high and low voltage connections of induction cells
Water	• make sure hands are dry when working with circuits • do not perform electrical experiments near water, wet floors, or wet benches • stand on rubber mats or carpet when working with electricity • outlets should be in waterproof boxes on the top of benches or suspended from the ceiling
Standards	• equipment should be CSA or ULC approved • periodically check for frayed cords, exposed live wires, or leakage of current • avoid use of extension cords • if it is necessary to use electrical cords, do not run cords across walkways or aisles
Safety	• avoid touching a live circuit with both hands • do not grasp an electrical device that has just been used • high and low voltage (Should be CSA approved.)

Mechanical Hazards

Item	Precaution
Equipment with moving parts	• tie long hair back • avoid loose clothing, hats with protruding brims, and jewellery • wear safety glasses or goggles • periodically check equipment to see that it is in good working order
Glassware	• make sure it is safe for heating—use brands such as Pyrex™ or Kimax™ • hot and cold glassware look alike—be sure of what you are touching • use tongs or heat resistant gloves to handle hot glassware • cool hot glassware on ceramic tiles or ring stand base • always clamp flasks and beakers when heating them on a ring stand

Radiation Hazards

Item	Precautions
Ultraviolet (UV) light	• if in use, make sure it does not shine in the eyes or on the skin • can cause "sunburn" and eye damage (conjunctivitis) • use protective glasses and an ultraviolet barrier skin cream
Visible light	• if bright enough, can cause eye damage • never look directly at a bright light source such as magnesium or the sun • be careful when using strobe lights as they may induce seizures
Lasers	• even at low power, can cause eye damage if the beam enters the eye • do not allow students to look at the beam • do not shine the beam on any reflecting surface • use only a low power laser • when in use, keep ambient light levels high so that students pupils are small • students may not use laser pointers or pens
Ionizing Radiation	• use low-intensity sources containing uranium, thorium, potassium, or rubidium • do not allow sources to come in contact with the skin • if sources are in powder form, keep sealed to prevent contact with the skin or ingestion

Workplace Hazardous Materials Information System (WHMIS)

The Workplace Hazardous Materials Information System (WHMIS) was legislated by the Canadian federal and provincial governments on October 31, 1988 as part of the Occupational Health and Safety Act. This was to ensure that all workers in Canada have information on any chemicals that they may come in contact with in the workplace. The three components to WHMIS are as follows.

Labelling

Labels on chemicals from laboratory supply houses which are packaged in quantities less than 10 kg must disclose the following information:

- name
- where a MSDS is available, a statement to that effect
- any hazards of the chemical
- precautionary measures to be followed
- where appropriate, first aid measures in case of exposure

If chemicals are removed and transferred to another container, the transfer container must be labeled clearly with enough information to enable the safe handling of the material.

In the lab, samples less than 100 mL in volume that are used in-house only, require a product identifier only.

Material Safety Data Sheet (MSDS)

All chemicals in stock in the schools must have an MSDS sheet. These provide more specific information about the hazards, possible health effects, and preventative measures. Teachers and students should be familiar with the type of information contained in a MSDS. Although the numbering of sections and the order of appearance may differ from supplier to supplier, the following nine categories must be on each MSDS.

	Category	Information
I	Product Identification and Use	• manufacturer's name • supplier's name
II	Hazardous Ingredients	
III	Physical Ingredients	• colour, form, solubility • melting and boiling points • vapour pressure, specific gravity
IV	Fire and Explosion Data	• flammability • flashpoint • fire fighting procedures
V	Reactivity Data	• stability and hazards
VI	Toxicological Properties	• LD-50 and LC-50 values • threshold limit values (TLV) • Effects of exposure • Carcinogenicity
VII	Preventative Measures	• protective clothing • protective equipment • spill and handling procedures
VIII	First Aid Measures	
IX	Preparation date of MSDS	

Each MSDS sheet for chemicals in the school must be updated at least every three years, and a copy must be available in the lab for use by teachers and students.

Education and Training

WHMIS is a system of information delivery to workers.

- Employers must ensure that their employees are informed about the hazards of any controlled products they may work with.
- The school is responsible for developing safe work procedures using knowledge of the job, information from the labels, and MSDS sheets.
- All science teachers should be sufficiently trained to use the information to protect themselves and their students.
- It is the responsibility of all teachers to adhere to safe working procedures and the responsibility of principals to insist that they are followed.
- The employer is responsible for worker education and training within WHMIS.
- Science teachers have a responsibility to educate their students in the aspects of WHMIS.

Hazardous Materials

The list of potentially hazardous materials identified in this manual is not all-inclusive, nor does it address all the hazards that can be encountered when handling chemicals. What is emphasized in these sections are those chemicals that have been listed by the Department of Education as restricted or prohibited, or have been identified by the National Institute of Occupational Safety and Health (NIOSH) as hazards.

Explosives

Explosives—an unstable substance capable of rapid and violent energy release.

The following substances are prohibited for use in schools. They should be removed only by persons trained in handling explosive materials.

Chemical	Formula
• Benzoyl peroxide	CH_2CHCN
• Carbon disulfide	CS_2
• Diisopropyl ether	$((CH_3)_2CH)_2O$
• Ethyl ether	$C_4H_{10}O$
• Picric acid	$2, 4, 6\text{-}(NO_2)_3C_6H_2OH$
• Perchloric acid	$HClO_4$
• Potassium metal	K

Highly Toxic Material

Highly Toxic—Agents or substances that when inhaled, absorbed or ingested in small amounts can cause death, disablement or severe illness.

- Adrenaline
- Barium hydroxide
- Chlorine
- Colchicine
- Mercury
- Mercury (II) chloride (Mercuric chloride)
- Mercury (II) iodide (Mercuric iodide)
- Mercury (II) nitrate (Mercuric nitrate)
- Mercury (II) oxide (Mercuric oxide)
- Mercury (II) sulfate (Mercuric sulfate)
- Nicotine
- Osmium tetroxide
- Phosphorus (white)
- Phosphorus pentoxide
- Potassium cyanide

- Potassium periodate
- Silver cyanide
- Sodium cyanide

Carcinogens

Carcinogen—A substance capable of causing cancer or cancerous growths in mammals.

Known labels indicate that enough information exists which shows a definite relationship between exposure to a substance and cancer in humans.

Probable labels indicate there is limited evidence in humans and/or sufficient evidence in experimental animals.

Some carcinogens are more potent than others, and risk increases with level and duration of exposure.

Known Carcinogens

- Arsenic powder
- Arsenic pentoxide
- Arsenic trichloride
- Arsenic trioxide
- Asbestos
- Benzene
- Benzidene
- Chromium powder
- Chromium (VI) oxide
- Lead (II) arsenate
- Sodium arsenate
- Sodium arsenite

Probable Carcinogens

- Acrilonitrile
- Cadmium powder
- Cadmium chloride
- Cadmium sulfate
- Carbon tetrachloride
- Chloroform
- Ethylene oxide
- Nickel powder
- o-Toluidine

Known Animal Carcinogens

- Acetamide
- Aniline (or any of its salts)
- Beryllium carbonate
- 1,2-Dichloroethane (Ethylene dichloride)
- 1,4-Dioxane (o-Dioxane)
- Formaldehyde
- Lead (II) acetate
- Nickel (II) acetate

Mutagens

Mutagens—Substances capable of causing changes in the genetic material of a cell which can be transmitted during cell division.

The extent of the hazard to humans associated with exposure to mutagens is less clear than it is with carcinogens. However, it is recommended that similar caution should be exercised in handling substances which are mutagenic.

Mutagens

- Acetamide
- Acridine orange
- Ammonium chromate
- Ammonium dichromate
- Ammonium bichromate
- Anthracene
- Antimony oxide
- Beryllium carbonate
- Cobalt powder
- Colchicine
- 1,2-Dichloroethane
- Formaldehyde
- Hydroquinone
- Indigo carmine
- Lead (II) acetate
- Osmium tetraoxide
- Potassium chromate
- Potassium permanganate
- Pyrogallic acid (Pyrogallol oxide, $C_6H_3(OH)_3$)
- Silver nitrate
- Sodium azide
- Sodium dichromate dihydrate
- Sodium nitrate
- Sodium nitrite
- Thioacetamide
- Toluene
- Urethane (Ethyl carbamate)
- Ultraviolet radiation

Teratogens

Teratogens—Substances which are capable of producing abnormalities in offspring resulting from exposure of the pregnant woman to the substance at a concentration that would be unlikely to have an effect on the woman. The human fetus is particularly at risk during the embryonic stage of development, which is between two and eight weeks.

Known or suspected teratogens

- Ethyl alcohol
- Iodide compounds
- Lead
- Methyl mercury
- Polychlorinated biphenyls
- Radioiodine

A number of drugs are also included in this list (e.g., heroin, cocaine, methadone, tetracycline, thalidomide). Ultraviolet radiation and diseases such as rubella and syphilis have been associated with congenital malformation.

Prohibited Chemicals

The following chemicals should not be used in any school; if they are found to be present, they should be disposed of immediately by trained personnel.

- Acrylonitrile
- All compounds of lead
- All compounds of mercury
- Ammonium dichromate
- Arsenic
- Arsenic trioxide
- Asbestos (in any form)
- Azobenzene
- Benzene
- Benzotrifluoride (Trifluorotoluene)
- Benzoyl peroxide
- Beryllium
- Beryllium chloride
- Bromine
- Cadmium
- Carbon tetrachloride
- Carbon disulfide
- Carbon monoxide
- Chlorinated ethers
- Chlorine gas
- Chloroform
- Chromic acid
- Chromium
- Chromium Oxide (Chromium trioxide)
- Cynogen (Oxalic acid dinitrile)
- Dichloromethane (Methylene chloride)
- Dimethyl sulfate
- Dimethyl sulfide
- Dimethyl ether
- Dinitrobenzene
- Ethylamine
- Ethylene dichloride
- Ethylene oxide
- Fluorine
- Formaldehyde
- Fuming acids (e.g., nitric, sulfuric)
- Gasoline
- Guanidine Carbonate
- Guanidine Nitrate
- Hydrocyanic acid
- Hydrofluoric acid
- Hydrogen sulfide
- Lead arsenate
- Metallic peroxides of Ba and Ca
- Mercury
- Millon's Reagent
- Nickel (II) sulfate
- Nickel
- Nicotine
- Nitrogen dioxide
- Nitroglycerin
- Pecrates
- Perchlorates
- Perchloric acid
- Perchloroethylene
- Petroleum naptha
- Phenol
- Phosgene
- Phosphorus chloride
- Picric acid
- Polychlorinated Biphenyl (Microscope immersion fluid) PCBs
- Potassium cyanide
- Potassium
- Powdered metals (e.g., Mg, Al)
- Sodium cyanide
- Sodium arsenate
- Sodium arsenite
- Sodium peroxide
- Sulfur dioxide
- Vinyl chloride

Restricted Chemicals

The following chemicals may only be used where schools possess adequate safety equipment and storage facilities to permit their safe use. These chemicals, where used, should be stocked in minimum quantities only.

- Acetaldehyde
- Acetylene
- Ammonium perchlorate
- Bromine (liquid) (Use bromine water where possible)
- Calcium carbide
- Cyclopropane
- Diethyl ether
- Dimethylamine
- Ethyl acetate
- Lithium (metal)
- Lithium hydride
- Methyl ethyl ether
- Nitric acid (can explode)
- P.T.C. (Phenylthiocarbamide or 1-phenyl-2-thiourea)
- Petroleum ether (Ligroin)
- Sodium (metal)
- Toluene

Chemical Storage

Traditionally, chemicals have been stored in schools using an alphabetical sequence. In some cases, flammables and acids are stored in appropriate cabinets but little else occurs. This makes it possible for highly reactive substances such as oxidizing agents and reducing agents to be placed side by side on a shelf, resulting in spontaneous reactions.

Ideal chemical storage would be to completely isolate each major class of material and even isolate some materials within each class. This, however, is not economically feasible considering the amount of chemicals stored in some of the high schools. In the appendix of these guidelines, you will find a sample of a storage plan.

A good chemical storage facility has the following characteristics:

- locked doors isolating the storage room from preparation and classroom areas
- a well designed room permitting safe storage of all chemicals
- chemicals segregated into classes
- a colour coded labelling system
- good ventilation (5.0 L/m^2 floor area) with a fan that is permitted to run continuously
- well lit and away from direct sunlight and heat sources
- explosion proof lights
- switches and fan motor housing should be installed to prevent fires from electrical shorts or sparks in faulty switches

- avoid floor chemical storage
- no top shelf chemical storage nor any chemicals above eye level
- shelves (preferably wood) attached firmly to the walls
- avoid metal shelf supports or clips
- provide anti-roll lips on all shelves
- acids, flammables and severe poisons should be in three separate cabinets
- nitric acid should be stored separately

Hazard Classes of Chemicals

Chemicals may be put into eight general categories for aid in creating a workable storage system and precautionary measures taken in storing these chemicals would be similar in each of the categories.

Hazard	Comment
Flammables and Combustibles	• stored in CSA approved cabinet away from strong oxidizing agents such as $KMnO_4$, K_2CrO_4, $K_2Cr_2O_7$, or HNO_3 • keep the cabinet in a cool place • vented • a 120 L cabinet should be sufficient for most schools • acetic acid stored here
Acids	• stored at floor level, in an acid cabinet or acid-resistant plastic trays • cabinet must be vented • store away from bases, active metals (Na, Li, Ca) and cyanides, sulfides, and sulfites • nitric and acetic acids should be stored separately
Bases	• store away from acids • in corrosion resistant plastic trays at floor level • vent aqueous ammonia ("ammonium hydroxide") periodically
Oxidizing Agents	• store away from flammable and combustible materials and reducing agents • nitric acid stored here
Reducing Agents	• includes metals and metal powders • store away from oxidizing agents • some, such as alkali metals, must be kept away from water sources
Compressed Gases	• store upright • in a cool, well ventilated place • away from other chemicals • secure to a wall or bench to prevent them falling
Toxic Substances	• store poisons above waist height in a locked cabinet

Hazard	Comment
General Storage	• all other chemicals may be in alphabetical order • separate incompatible chemicals (see appendix for incompatibility of chemicals • store organics and inorganics separately

Do not order more chemicals than can be used in a year and date as they are received.

Spills

Hardly a day goes by in a school lab without a spill of some kind. The obvious teacher reaction is to ensure that no student has been injured by the material spilled. Refer to MSDS sheets for direction. Following this, the chemical spill may be dealt with as follows:

Spill	Procedure
Small Spills	• weak acids and bases can be flushed down sinks with large amounts of water • solvents may be evaporated in the fume hood • for poisonous, corrosive, or reactive materials, refer to MSDS sheets
Large Spills	• acids should be neutralized with dry sodium carbonate, then with plenty of water • bases should be neutralized with dilute HCl or acetic acid, then with plenty of water • absorb with vermiculite or diatomaceous earth and disposed of according to the Department of Environment guidelines • for large spills of poisonous, corrosive, or reactive materials, evacuate the lab, notify administration and seek immediate assistance from the Department of Environment • commercial spill kits may be obtained from scientific supply companies
Mercury Spills (NOTE: Mercury is prohibited.)	• immediate and thorough clean-up is imperative • provide maximum ventilation through doors and windows • never sweep with a broom nor use a vacuum • wear gloves and cover shoes with plastic bags • push pools of mercury together • pick up pools with a dropper pipette; transfer droplets to a seamless polyethylene or polypropylene bottle; store under a layer of water or oil and cover securely • good ventilation must be continued

Spill	Procedure
Solid	• sweep up with brush into a plastic dustpan and placed in a water container for disposal • see appendix for disposal methods • clean, broken glass should be placed in the glass disposal methods • broken glass contaminated with a hazardous solid should be placed with the spoiled solid for disposal
Liquid	• absorb with diatomaceous earth
Acids and Bases	• acid—sprinkle with solid sodium carbonate or sodium bicarbonate • when fizzing (CO_2) stops, sweep with a brush into a dustpan and dispose of in the glass container • base—neutralize with a weak acid such as solid citric acid, boric acid or sodium bisulfate • once neutralized, sweep up like a treated acid spill
Organic Liquids	• absorb with a spill pillow or scoopfuls of dry, solid absorbent • put in container for disposal according to table in the appendix

Biohazardous Materials

In 1990, The Nova Scotia Department of Education produced the *Biohazardous Materials Safety Manual* that had very stringent guidelines for the use of Biohazardous materials. The following is quoted from that manual:

"In laboratory exercises ..., it is impossible to guarantee an absolutely sterile environment for all teachers and students at all times. It is, then, wise to prohibit the use of potentially dangerous biological materials during laboratory work and demonstrations done in the classroom. This is particularly important because some infectious organisms have been found to survive long periods of drying.

Concerns have been raised by the Canadian medical community regarding the handling of mammalian tissue, partly in response to the emergence of pathogens such as the virus which causes Acquired Immune Deficiency Syndrome (AIDS) and other diseases such as Hepatitis.

The education value of investigations such as blood sampling or cheek cell scrapings cannot justify the increased health risk of these and other related procedures to students and staff. The Nova Scotia Department of Education firmly believes that the health and well-being of all members of the education community must be a prime consideration in selecting learning activities."

The issue of some biological hazards has already been introduced. As well, a summary of the major guidelines is given below. See Appendix K for additional information.

Guidelines

- Students and teachers are to be informed of procedures for decontamination and biohazardous waste disposal.
- Handling body substances of unknown status could endanger health.
- Hands are to be scrubbed at the end of every lab session and adequate facilities for this must be provided by school boards.
- Staff and students will follow the guidelines in the Biohazardous Materials Safety Manual.
- Present stocks of formaldehyde are to be disposed.

Prohibited

Experiments or demonstrations involving

- mammalian blood
- urine and fecal materials
- cheek cell scrapings
- human cell or tissue sampling
- fresh or frozen mammalian tissue

The use of human saliva is limited to the careful use of sterile techniques with swabs and Petrie dishes.

Disposal of Biological Materials

All microbiological specimens and dissected organisms should be incinerated. If this procedure is not possible, the remains of animals are to be carefully sealed in heavy biohazard bags and sent to a landfill site. Microorganism cultures should be autoclaved, sealed in a biohazard bag and sent to a landfill site. Liquid cultures should be autoclaved and flushed down the drain with large amounts of water. School boards should identify autoclaves and incinerators which can take these materials.

Mechanical and Electrical Equipment

Mechanical and electrical hazards will seldom exist in a well maintained laboratory. All equipment must be CSA approved and in good working order.

Most of the items mentioned below have already been covered on pages 13–17, so a summary is provided here.

Mechanical Hazards

Hazard	Result
Tools	• careless use of tools • tools in poor condition
Storage of Equipment	• if stored overhead, may cause injury to the back, arms, legs, or head when being lifted • may fall or slip off a shelf causing injuries
Rotating equipment	• fingers, long hair, and loose clothing may get caught if guards, lids and covers are not in place

Electrical Hazards

Hazard	Cause
Fire, electric shock, and damage	• frayed or broken electric cords • improperly used equipment • equipment that is not CSA approved • electric equipment not properly grounded • inadequate installation or improper alterations to an electric power system • improper use of high voltage equipment

Mechanical and Electrical Hazards Protection

Accident prevention will depend on the proper maintenance of all mechanical and electrical equipment and the careful instruction of students in the safe use of the equipment. The onus is on the teacher to be aware of potential dangers and to convey this information to the students.

Teachers must

- maintain all equipment and tools in good working order
- instruct the students in the safe use of all equipment and tools
- be sure that all rotating equipment are operated with all covers, lids, and guards in place
- require that eye protection be worn during any grinding or pounding operations
- remind students to tie up loose clothing and long hair
- clearly tag, or remove, all faulty equipment
- use only CSA or ULA approved equipment
- ensure that any electrical modifications are made by qualified personnel only
- use electric equipment at its rated capacity only
- be sure all equipment is shut off when not in use
- ensure regular safety inspections
- store all heavy items as close to the floor as possible

Accident Prevention and Safety Management

In this section, some general aspects of fire safety in science laboratories are listed. As well, there are many possible sources of fire. Being aware of these can help a teacher to prevent a fire.

Fire Safety

Hazard	Cause
Causes of Fire in the Lab	• ignition of solvent vapours • ignition of reactive chemicals • uncontrolled chemical reactions • inadequate storage and disposal • heating due to electrical faults • loose clothing and hair • misuse of gas cylinder • inadequate maintenance • static electric build up • inadequate lab design • inadequate temperature control

There are three avenues for fire safety.

Safety Classification	Procedure
Prevention	• eliminate flammable or potentially explosive materials • proper handling of chemicals during storage, spills, and disposal • education of students
Evacuation	• evacuate students immediately • practice fire drills • plan escape routes and alternate routes • clearly mark exits • evacuate in an orderly manner
Control	• remove the fuel (e.g., shut off gas valve) • remove the oxidizers (usually air) by using fire blankets, foam, carbon dioxide, or sand • remove the energy source—cool the material below its ignition point with a substance such as water

Fire Equipment

There are a number of pieces of equipment that each school should have in order to aid in the control of a fire. The first of these is the fire extinguisher. There are specific fire extinguishers to use for different classifications of fires.

Fire Classification	Fire Extinguisher
Class A—those involving ordinary combustible materials such as wood, cloth, paper	• water • dry chemical extinguisher may also be used (ABC)
Class B—fires involving flammable liquids such as solvents, greases, gasoline, and oil	• dry chemical foam, CO_2
Class C—fires involving electrical equipment	• non-conducting agents such as dry chemical or carbon dioxide
Class D—fires involving combustible such as magnesium, sodium, lithium, powdered zinc	• special dry powder medium or dry sand

- There should be an adequate number of suitable fire extinguishers.
- The fire extinguishers must be maintained in operable condition and completely checked at least once a year.
- If used, they must be recharged before being used again.
- The class and use of the extinguishers must be clearly marked.
- They must be located in conspicuous places which are clearly marked by signs.
- They should be mounted at an accessible height and located near area of use.

In addition to fire extinguishers each lab should have the following:

- a fire blanket made of fire-proof wool/rayon material; not to be used where spillage and fire spreading is possible
- teachers trained in the use of the appropriate equipment
- sand

In case of fire, teachers should do the following:

- evacuate all students
- in most cases, the fire department should be called
- if it is a small fire in a container, allow it to burn out
- if larger, place a fire resistant blanket cover over the mouth of the container
- if it cannot be contained, evacuate and call the fire department
- **never** throw water on a chemical fire
- **never** use a fire extinguisher on standing beakers or flasks
- **never** turn on water after a flaming container has been placed in the sink

First Aid in the Laboratory

First-Aid Training

All teachers should be able to provide first aid to students for whom they are responsible. Ideally, St. John Ambulance or similar first-aid courses should be taken and successfully completed. These courses require updating from time to time. In addition to the knowledge of the teacher with regard to first aid, many students, particularly at the higher grade levels, are qualified first aiders as a result of their involvement with ski patrols or swimming programs. These students should be identified in the event that their services are required. Although not all teachers may be qualified first aiders, some must be. It should be noted that only first aid is required and that a relatively small number of emergencies need be dealt with. Accident victims must be turned over to competent medical specialists as soon as possible. The following lists typical injuries with which teachers should be familiar.

Shock

Shock may result from any injury or the quick onset of serious illness—it causes the body's processes to slow down. The symptoms of a traumatic shock include pale, cold, and sometimes moist skin, rapid pulse, and sometimes, unconsciousness. Teachers should be aware of the possibility of shock and know how to treat it. The treatment consists of having the victim lie down with the feet slightly elevated. Cover the person to keep him or her warm and do not move the victim unless it is necessary in order to reach medical help. Treat the condition that caused the shock (e.g., bleeding, fracture, etc.). Medical help should be secured as soon as possible.

Fainting

Fainting has many causes: the sight, or talk of, blood; the loss of blood; long periods of standing, particularly in a warm room; lack of food; and reaction to an accident, even a slight one. Ensure that the victim is not suffering from shock or diabetic coma by smelling the breath. The treatment is to lay the victim down with head

lowered and the feet raised; loosen tight clothing; and ensure fresh air. Allow the person to rest 20–30 minutes after recovery. To prevent injury by falling in a faint, it is good first aid practice to have a patient sit rather than stand when administering first aid, even when the operation is as simple as applying a bandaid.

Bleeding

Bleeding is controlled by placing a pressure dressing directly over the wound and applying pressure by hand or with a pressure bandage. Clean, sterile materials should be available; alternately, available materials such as facial tissue or toilet paper may be used. The injured part should be raised and immobilized and treatment for shock given, if required. The victim should rest.

Scratches, Punctures, and Splinters

Minor scratches and punctures, which are common in science activities, are normally controlled by applying a bandaid and a disinfectant, if required, to prevent infection. Large splinters should not be removed as this may cause extensive bleeding. They should be loosely wrapped with a sterile bandage and the victim given medical treatment.

Accidents to the Eye

If solids or liquids or gaseous irritants enter the eyes, they must be removed immediately with copious quantities of water. **Water only is to be used**. The head should be tilted so that the water will not run from the injured eye to the other one. If contact lenses are worn, they must be removed immediately. While an eye wash fountain is ideal, any source of water (hose, beakers, glass, eye cup) may be used. It is essential that the eye is open, even if it has to be forced open, so that the water may reach the contaminated substance. A physician must be consulted as soon as possible. Frequently it is found that, as a result of being near splashing chemicals, the victim only imagines that there is something in the eye, but treatment should be undertaken in any case.

Burns

Immerse the injured part in cold water to relieve pain. Do not break blisters. Covers the burn loosely with a clean dressing and secure medical attention if required. Do not apply any ointment as this will have to be removed if further treatment is required.

Poisons

Contact the Poison Control Centre (phone: 1-800-565-8161) if in any doubt about required action. If an alkaline or corrosive substance has been taken, do not induce vomiting. Check the container to determine if the antidote is listed on it.

Chemicals on Skin or Clothing

Some chemicals such as acids and bases burn the skin rapidly. They must be removed by flushing with water immediately. Clothing must be removed and discarded with initially more regard for safety then modesty. If an acid burn is involved, wash with bicarbonate solution. If it is a base burn, wash with dilute acetic acid or boric acid. Both these solutions are to be available when acids or bases are in use in a laboratory or classroom.

Electrical Shock

Only CSA-approved apparatus should be used in a laboratory. Three-prong grounded plugs should be used; removing the ground plug is unacceptable. A severe, even fatal, shock may be received from any voltage above 40 volts; 115 volt house wiring deserves the respect of its users. First aid for electric shock requires the following steps:

1. Remove the patient from the electricity by turning it off or moving the victim with a nonconductor such as dry wood or clothing.

2. If breathing has stopped, begin mouth-to-mouth resuscitation immediately.

3. If heartbeat has stopped, cardiopulmonary resuscitation is required immediately. Have another person call medical help and continue resuscitation until help arrives.

Students Having Medical Problems

It is essential that teachers are aware of any students who have medical problems such as diabetes or epilepsy that may cause them to be incapacitated. Teachers should also know of students who may be taking drugs that may have side effects or students who have allergic reactions. In all such cases, any precautions, treatment in the event of attacks, and emergency numbers should be known. Any information of this type provided to the teacher should be treated as confidential.

Emergency Numbers

Emergency numbers should be posted in a conspicuous place in the laboratory or classroom, as well as by the telephone that would normally be used in the event of an accident. These numbers should include fire, police, poison control, hospital, ambulance, and school board.

First-Aid Kits

First-aid kits for a school should contain those materials that will be useful to the teacher planning to deal with those minor accidents outlined here. Prepared kits frequently contain materials that would never find any use in actual practice in a school. Included in the first-aid kit should be bandaids, sterile gauze bandages, adhesive tape, an antiseptic ointment, tweezers, and scissors.

Where there are more than 20 and fewer than 50 employees regularly employed on any one shift at a worksite, the employer shall provide a number 3 first-aid kit.

A number 3 first-aid kit will contain:

Equipment

- 1 first-aid guide
- 1 first-aid record book
- 1 pencil
- 12 safety pins
- 1 splinter tweezers
- 1 pair of 100 mm scissors
- 4 pairs of disposable latex gloves made of material that provides an equivalent level of protection against the spread of infections or contagious conditions
- one marked plastic bag for disposal of biohazardous waste
- one airway barrier device for rescue breathing

Dressings

- 6 sterile bandage compresses (100 mm x 100 mm)
- 32 sterile adhesive dressings (25 mm wide)
- 32 sterile pads (75 mm wide x 75 mm long)

Bandages

- 6 triangular bandages (1 m)
- 3 roller bandages (50 mm wide)
- 2 rolls of adhesive tape (25 mm wide x 2.5 m long)

Antiseptics

- disinfectant in the form of
  - a 100 mL bottle of adequate antiseptic
  - 12 individually wrapped towelettes with an adequate antiseptic
  - 24 hand cleaners

The above listing is the minimum required by law. In addition, the following would be recommended:

- 4.5 m tubular finger bandages with applicator
- 10 finger tip dressings
- 10 knuckle pad dressings

These kits should be checked periodically (at least once a month) as some items such as Band-aids tend to be used often and may need frequent replenishment.

Field Trips

Planning is essential for safety in any outdoor experience and should include familiarizing students with the proper clothing (footwear, jacket, head gear, etc.) and training in how to carry knapsacks if they are to be used. Other skills such as canoeing, cross-country skiing, etc., must be taught before the event is to take place. All students should be familiar with emergency procedures in the event that they become separated from the group. A buddy system should be instituted for the protection of the students. Many inconveniences can be avoided with appropriate planning.

Suitable equipment should be taken to deal with weather change, purifying drinking water, insect bites, allergies from plants such as poison ivy and poison oak, burns from campfires, and becoming overtired.

A first-aid kit taken on a field trip should contain the same items as outlined for the school first-aid kit and, in addition, sodium bicarbonate for insect bites, an inflatable splint to be used for sprains or breaks, antihistamine (e.g., Benadryl) for serious insect bites, quaters for phone calls, a flashlight, water, a compass, a map, waterproof matches, a signal device such as a whistle and reflector, emergency food (e.g., chocolate, nuts, etc.), and insect repellent.

Legal Responsibility re First Aid

The legal aspects of first aid have been discussed in great detail to the point where s me persons are reluctant to provide it. It should be noted that it is a person's legal duty, under the Criminal Code of Canada, to provide first aid to the extent to which one is able to do so. One is also responsible, once having assumed the care of a victim, to continue care until he/she is handed over to someone else willing to accept the responsibility for care—preferably a nurse or physician. While it is assumed that a teacher has legal obligation to render voluntary assistance in an emergency to a student, it is the right of a person to refuse treatment that is offered. To attempt contrary to the wishes of the victim, with the possible exception of suicide, constitutes assault. In general, the willing acceptance of ordinary treatment by a conscious adult or older child may be looked upon as consent to treatment. An unconscious patient should be given all necessary care. Urgent treatment should not be withheld from a child because the parents are not present to give consent. In the absence of parents, nonemergency measures should be deferred.

The conscientious and kindly care of all patients, according to the best of your knowledge and skill, and with accurate observation and careful records, common sense, and common courtesy will carry you safely through practically all the legal complications of first-aid work.

Bill 49 of the Nova Scotia Legislature, which is called the Volunteer Services Act, relieves a volunteer of liability for damages for injury or death of the patient unless gross negligence is established. The volunteer is not liable for damage resulting to property while offering assistance.

The following table provides guidelines for the most common accidents in the laboratory. Seek medical attention for any injuries.

Injury	Response
Burns	• apply cold water
Cuts and Bruises	• stop any bleeding by applying direct pressure • cover cuts with a clean dressing • apply cold compresses to bruises
Fainting	• leave the person lying down • loosen any tight clothing • keep crowds away
Foreign Matter in the Eye	• flush with plenty of water for at least 15 minutes and seek medical attention
Poisoning	• note the suspected poisoning agent • call Poison Control Centre (1-800-565-8161)
Any spills on skin	• flush with large amounts of water and use safety shower NOTE: Some chemicals react with water; exercise caution.

Personal Protective Equipment for Students

If injuries to students result from the failure to have or use personal protective equipment, negligence may be claimed. Safety training is an integral part of learning lab techniques, and it is an excellent way of ensuring that safety become a lifelong practice.

Safety Item	Comments
Safety Glasses or Goggles	• students must wear eye protection • shared goggles should be sterilized between uses with an ultraviolet radiation or a disinfectant solution • prescription glasses **do not** provide adequate protection • safety glasses or goggles must have fitted side shields • contact lenses—see Appendix E: Contact Lenses
Laboratory Coats	• should be made of 100% cotton • aprons do not provide sufficient protection and therefore are not recommended • each student should purchase or be provided with his/her own lab coat
Disposable Gloves	• should be available for students when handling corrosive chemicals, toxic chemical, biological stains, or potentially infectious material • Note: some disposable gloves offer no protection against some organic solvents

Safety Equipment for Science Classrooms/Labs

Equipment such as first-aid kits, showers, fire blankets, extinguishers, eye washes, sand buckets, etc., should be properly labelled with instructions for use. In the event that any of this equipment is not readily visible, signs should indicate its location.

The teacher and students should be familiar with the location and the use of safety equipment. It is imperative that the equipment be checked at least twice a year and should be located for easy access. The following is a minimum list of required safety equipment items.

Equipment	Comments
Fire Extinguisher	• ABC type dry chemical
Fire Blanket with Wall Stand	• replace existing asbestos blankets with wool/rayon type • only to be used for smothering clothing fires
Eye Wash Station	• plumbed eye wash preferred
First Aid Kit	• minimum required contents as specified by NS Government
Emergency Shower	• should be readily accessible

Equipment	Comments
Safety Goggles	• teachers and students must wear these whenever there is likelihood of eye injury
Face Shield	• to be worn by the teacher when previewing unfamiliar activities • used when mixing solutions
Safety Shield	• to be used when previewing an unfamiliar activity
Glass Disposal Container	• a metal pail or cardboard box labelled "broken glass, handle with care"
Chemical Spill Kit	• sources—chemical supply companies • used for acid, base, organic solvent, and mercury spills
Chemical Resistant Rubber Gloves	• used for cleaning up spills or for handling corrosive or toxic chemicals • for use when handling preserved organisms
Lab Coats/Aprons	• should be worn in the lab and made of 100% cotton
Heat Resistant Gloves and Tongs	• for use when handling hot objects • gloves should be made of treated textures silica or woven fabric • do not use **asbestos gloves**
Fume Hood	• must have a working extractor fan • should be inspected regularly
Handwashing Facilities	• should be in or near each science class/lab
Bentonite/Kitty Litter	• used for chemical spills
Dustpan and Brush	• for brushing up used sand, vermiculite, and broken glass • wash and clean thoroughly after each use
Heavy Duty Garbage Bags	• for disposal of all solid waste • double bag if necessary • label bags and dispose of each spill separately
Locked Storage	• used for dangerous chemicals
Acid Storage Cabinet	
Rubber Transport Bucket	• used to transport bottles of concentrated acid
Flammables Storage Cabinet	
Master Propane Gas Control	

Fume Hoods

- must have a minimum airflow (velocity) of 0.5 m/s
- should be fitted with a sink
- must be provided with adequate lighting (500–700 lux ambient lighting
- all controls for its operation must be located outside the fume hood
- must be connected to a common duct
- must not re-circulate discharged air into the lab or other work areas
- must be checked regularly to ensure proper working order

Eye Hazards

The eye is probably the most vulnerable part of the body surface from an injury standpoint. It is easily damaged and because it has few blood vessels, injuries heal more slowly and the eye may not fully recover.

Injury	Comment
Foreign Bodies	• the most common danger • particles lodge on the surface and become very irritating • sharp objects may penetrate deeply where they may cause no pain • some chemicals have a toxic effect on eye tissue • from an exploding test tube or flask • seek medical attention
Chemical Agents	• acids—the eye will set up a protection barrier • caustic materials—readily penetrates into the eye tissue
Radiation	• ultraviolet, visible, infrared can cause damage if the intensity level is sufficiently high • lasers—require special eye protection

Approved eye protection must be worn at all times by everyone in a laboratory situation involving chemicals, explosive materials, compressed gases, hot liquids or solids, injurious radiation, or other identifiable hazards.

Dangerous Reactions

Chemicals must only be used for the purposes for which they were purchased. Procedures for their use must be clear to the student before experimenting begins. Changes in procedures must never be made without the teacher's specific permission. This permission must not be given unless the teacher is certain that the change is safe.

To prevent unplanned experimentation, any potentially dangerous chemicals (if not all chemicals not actually in use) should be securely locked. Particular attention is required for

strong acids and bases, strong oxidizing agents, and organic substances, which tend to be easily oxidized and flammable.

Specific Hazardous Reactions

Many explosions, fires, and asphyxiations are caused by the accidental combination of potentially dangerous substances. The following is a list of such combinations.

- Nitric and/or chromic acids with any of the following:
  - acetic acid
  - ethylene glycol
  - peroxides
  - permanganates
  - hydroxyl compounds
  - ammonia
  - camphor
  - glycerol
  - turpentine
  - alcohol
  - hydrogen sulfide
  - aniline and hydrogen peroxide
  - zinc
  - aluminum
  - magnesium

  (Spontaneous ignition or explosive)

- Nitric and sulfuric acid with acetone (Spontaneous ignition or explosive)

- Acetylene in the presence of copper tubing with halogens, silver, mercury and their compounds, and hydrogen peroxide (Explosive)

- Aluminum powder with iodine and water or hot vapours of chlorinated hydrocarbons (Explosive)

- Aqueous ammonia with iodine, silver, or mercury (Explosive)

- Ammonia with sodium or calcium hypochlorite (Javex) (Poisonous gas); with halogens, hydrogen, and hydrogen fluoride (Explosive)

- Ammonium nitrate, potassium chlorate, chromates, potassium permanganate or sulfur with organic compounds (Explosive)

- Liquid bromine with ammonia, acetylene, hydrogen, turpentine, and finely divided metals (Exothermic)

- Chlorine with ammonia, hydrogen, turpentine, acetylene, benzene, and finely divided metals (Explosive)

- Activated carbon and calcium hypochlorite (Explosive)
- Sodium or calcium carbide with water (Explosive)
- Cyanides with acid or water (Poisonous)
- Hydrogen peroxide with most metals, metal salts, flammable fluids, combustible materials (Rapid decomposition)
- Sulfuric, nitric, hydrochloric, and phosphoric acids with chlorates, perchlorates, permanganates (Explosive, exothermic)
- Mercury oxide with sulfur, heated (Explosive)
- Oxalic acid with silver and mercury (Explosive)
- Oxygen (gas) with grease, hydrogen, flammable liquids, solids, and gases (Explosive)
- Phosphorous pentoxide with water (Exothermic)
- A combination of potassium chlorate, sugar, and concentrated sulfuric acid is unpredictable (Explosive)
- Potassium nitrate with sodium acetate in the solid state (Expl sive)
- Potassium permanganate with glycerol, benzaldehyde, or ethylene glycol (Exothermic)
- Sodium peroxide with methyl alcohol, acetic acid, acetic anhydride, benzaldehyde, carbon disulfide, glycerol, ethyl acetate, and ethylene glycol (Explosive)

Chemicals Producing Toxic Hazards

A combination of a column 1 chemical with the chemical opposite in column 2 will produce the toxic chemical shown in column 3.

Column 1		Column 2		Column 3
Chemical A	+	Chemical B	→	Toxic Chemicals
arsenic materials		any reducing agent		arsine

Column 1	Column 2	Column 3
ammonia	Javex (sodium hypochlorite)	chlorine
azides	acids	hydrogen azide
azide salts	heavy metals (e.g., Cu, Pb)	metallic azides
cyanides	acids or H_2O	hydrogen cyanide
hypochlorites (Javex)	acids ("Plumber's Helper")	chlorine or hypochlorite acid
nitric acid	copper	nitrogen dioxide (nitrous fumes)
nitrites	acids	nitrous fumes
nitrates	sulfuric acid	nitrogen dioxide
selenides	reducing agents	hydrogen selenide
sulfides	acids	hydrogen sulfide

Potentially Hazardous Experiments and Possible Substitutes

Experiment	Reason for Danger	Possible Substitute
Burning Magnesium	Eye damage UV light produced	Burn behind glass or cobalt glass.
Decomposition of mercuric oxide (Law of Definite Proportions)	Mercury poisoning	Drive off water of crystallization from $BaCl_2$ $2H_2O$.
Determination of boiling point using carbon tetrachloride	Vapours are poisonous	Use water instead.
Preparation of oxygen (heating potassium chlorate)	Violent reaction of chlorates when in contact with organic material; e.g., carbon, burnt splint, rubber, or dust.	React H_2O_2 with MnO_2 cautiously.
Use of mercury in Boyle's law apparatus	Mercury poisoning	Use water instead.

Experiment	Reason for Danger	Possible Substitute
Heating any concentrated acid	Poisonous vapours during heating. Severe burns can be suffered from hot acid.	Use a fume hood or do not heat concentrated acids.
Zinc and sulfur explosion (to illustrate a synthesis reaction)	Spews out molten sulfur, zinc, and sulfur dioxide. Explosive power may be enough to break the test tube. Zinc sulfide is an irritant.	Teacher demonstration only—use small amounts (cover a dime). Operate on flat tin can lid.
Any experiment involving sodium, potassium, lithium, phosphorous	Potential high combustibility	Teacher demonstration only. (Calcium or sodium alloy is often sufficient for this demonstration.)
Vapourization of iodine, benzoic acid	Toxic bronchial irritants	Teacher demonstration or use minute quantities.
Distillation of crude oil.	Flammable	Use electric heater.
Use of flammable volatile liquids, e.g., ether, alcohols as solvents	Should not be used when sparks will be present, e.g., spectrum tubes, electric switches, static discharge.	Use nonflammable liquids rather than ether. Always check the surroundings for apparatus that may produce sparks.
Laser beams	Eye damage	Never look directly into the beam. Prevent strong and direct reflections.
Solubility using carbon tetrachloride	Vapour poisonous	Use T.T.E. (Trichlorotrifluoroethane)
Radioactive materials	Radiation	Use adequate shielding.
Static electricity discharge from Van der Graff generator	Possible discharge to the eye	Wear glasses and keep front of face away from charged sphere.
Dissection of castor bean with razor blades	Juice (RICIN) from these beans will cause death if it gets in the blood stream.	Use lima bean. **Use of castor beans is prohibited.**
Use of dissecting needle	Possible eye damage	Use with great care. (Safety glasses)
Use of carbon tetrachloride for flotation experiments	Vapour poisonous	Use glycerol, mineral oil (Nujol) or T.T.E.

Generation of Toxic or Irritant Gases

In addition to those chemicals designated as prohibited and restricted, many substances of a hazardous nature may be generated in the laboratory. Gases such as ozone (O_3), sulfur dioxide (SO_2), hydrogen sulfide (H_2S), nitrogen dioxide (NO_2), and chlorine (Cl_2) plus gaseous forms of hydrogen chloride (Hcl), bromine (Br_2), iodine (I_2), and diphosphorous pentoxide smoke (P_2O_5) are toxic and/or irritating products. Other toxic substances such as sulfuric acid (from sulfur trioxide) and ammonium chloride (NH_4Cl) may be present in the air as finely divided particles. Teachers should avoid producing these substances, but where they must be used, effective ventilation, such as a properly operating fume hood, must be provided.

Disposal of Chemical Waste

When chemicals have been used or are no longer safe to store, they must be discarded in such a way that they will not cause damage by exploding, poisoning the surroundings, starting fires, or damaging plumbing. It is essential to know the physical and chemical properties of any substance before it is discarded—state; flammability; how corrosive it is; how reactive with water and other chemicals in the sewer system such as copper, lead, and plastic; and how poisonous the substance will be to the environment at the sewer outflow.

Problems with blocked-up plumbing can be avoided if a small plastic container is provided in each sink for nonreactive solid waste. Suitable plastic containers can be made by cutting the top from laundry bleach bottles. Holes can be punched in the bottom of these containers to prevent them from filling with water. These containers should be emptied regularly.

When in doubt about the disposal of a chemical, teachers should research the chemical for appropriate procedures. If doubt still remains, the teacher should discuss the matter with school officials.

The usual ways of disposing of chemicals are

Liquid

Corrosive or caustic liquids can be disposed of by pouring them down the drain while flushing with copious amounts of water.

Flammable liquid waste should never be poured down the sink drain because the flammable vapours could accumulate in the plumbing, move to an ignition source, and cause a serious explosion. When performing experiments that result in the accumulation of flammable liquid wastes, a safety can should be provided for collection of wastes, and the teacher should dispose of the flammable liquid.

Carcinogenic substances should be referred to an appropriate agency for disposal. **NOTE**: Liquid bromine **must not** be poured down the drain because vapours are only partially soluble and are toxic and reactive with a variety of reagents.

Solid

It is an excellent practice to use separate containers for flammable solid wastes and nonflammable solid wastes, especially broken glassware. The mingling of broken glassware with paper and other trash can present a definite hazard to the custodial help performing collection and disposal.

The disposal of waste chemicals and potentially hazardous materials is by necessity a common occurrence in school science laboratories. This manual cannot provide specific detailed information for the disposal of such materials, but what follows is a very general synopsis for disposal of various hazardous materials.

Hazard	Disposal
Chemicals	• follow procedures on MSDS sheets • adhere to Nova Scotia Department of Environment regulations • do not use methods not approved by the Department of Environment • refer to The Flinn Chemical Catalogue for "do it yourself" disposal • chemicals can damage a septic system • encourage your Board to initiate a board wide collection and disposal of hazardous waste; retain chemicals for this collection.
Glass	• collect broken glass in a properly labelled container • arrange for disposal with custodial staff
Biological Materials	• dissected specimens and organisms to be incinerated or sealed in heavy plastic and sent to a landfill site • cultures, where permitted, must be sterilized before disposal; sealed in a heavy gauge plastic bag and sent to a landfill site • liquid cultures must be autoclaved then flushed down the drain with large amounts of water • syringes, needles, scalpels, and razor blades are to be put in metal or plastic containers and labelled

Safety Professional Development

Professional Development Tips

Little success can be expected from professional development unless the teachers attending see it as important to their work with students and feel that it has the active support of the school administration—principal, curriculum supervisor, and superintendent. Administrative support will extend to the provision of any necessary equipment for the school that is recommended during professional development sessions. Administrative support should be committed before the sessions.

Five steps have been identified for professional development planning:

1. *Identify needs and list them in order of priority.*

2. *Set goals and objectives.* Both organizers and participants must have a clear understanding of what exactly is to be achieved. Some general goals are listed in the following section. Specific objectives for each school or system need to be developed for professional development. The objectives serve to assist in planning, to direct resource persons, to focus teachers' attention prior to and during the session, and to organize the evaluation.

3. *Select activities.* The activities planned should include a variety of formats—discussion, role-playing, case study, and lecture. These activities should be designed to accomplish the objective—lecture to provide information, discussion to change attitudes, etc.

4. *Assign resource persons.* Resource people are frequently the key to success. Using local teachers and supervisory staff should be seriously considered because they are familiar with local conditions, have credibility with their peers, are available for follow-up afterwards, and tend to be more influential than outside "experts." It is essential that resource persons are willing and able to work to the agreed-upon objectives.

5. *Evaluation.* Evaluation is required to assess the effectiveness of the session, to plan the next step in the ongoing professional development program, and above all, to evaluate the effectiveness of the professional development in changing schools to make them safer places for students and teachers.

Goals for Safety Professional Development

The ultimate goal of safety professional development is to avoid accidents in the school. To reach this goal, the following objectives should be considered.

- Raising awareness of safety in the minds of teachers by increasing their knowledge of resources available, procedures, and the need for skills such as first aid.
- Strengthening background knowledge in areas such as dangerous chemicals, proper storage, and dealing with emergencies.
- Planning, setting up, and evaluating a school safety program.

It should be kept in mind when goals are formulated for a specific professional development session that they should be narrow enough to be met in the time available and broad enough to be useful to as many teachers as possible. It cannot be overemphasized that the goals must be clear, not only to the organizers, but also to the participants. These goals should be provided before the sessions to focus the attention of teachers on the topic under consideration. Obviously, not all of the above goals can apply to every safety professional development session.

Techniques for Safety Professional Development

Successful professional development will encourage active participation rather than passive listening or watching. Possible activities for professional development include discussions based on films, overhead transparencies, and slides; planning sessions in which participants will plan certain aspects of safety for their school; case studies and tests; accident simulation, perhaps by role-playing; and demonstrations (e.g., incompatible chemicals). There is no doubt that the activity approach, like any good thing, can be taken to extremes; there is a need for other formats to provide variety in the sessions. A description of various kinds of sessions that might be used to meet the goals for safety professional development follows.

Discussion Sessions

When discussion sessions are held, it is very important that effective direction is given so that productive discussion takes place. Leadership that will direct the discussion into positive channels is essential for success. The following techniques are suggested.

One type of discussion starter is a case study of accidents. It is suggested that a variety of studies be provided for different grades and disciplines. The studies should be based on the assumption that all accidents are predictable, and the case study should provide the conditions for a group to predict the outcome of an incident. The actual outcome can then be reported and discussed.

Another form of case study could be an accident report with the group asked how it could be prevented. The goal of this type of approach is to initiate discussion that should become directed to the teachers' actual situation.

Overheads predicting unsafe laboratory practices can be placed on a screen and teachers asked to identify hazards that could result in an accident.

Some excellent attention-getters for professional development would be dust explosions or demonstrations of incompatible chemicals such as glycerine and potassium permanganate. Teachers, like students, often react favourably to "pops" and "bangs." Demonstrating a small explosion safely can provide a useful learning experience.

Having initiated discussion, it is essential that a strong chairperson be present to ensure that the discussion follows useful channels. Allowing discussion to turn into a complaint session is usually unproductive. A complaint should always be turned into a clear statement of a problem, and a solution to it should be sought by the group.

In addition to discussion sessions, other formats such as "buzz" sessions and brainstorming should be considered. These could deal with topics such as "What are the situations that should be looked at in our school with regard to safety?", "How do you discuss safety without making students afraid of science?", "Should there be parental involvement in the safety program?"

Planning sessions are all important in school professional development sessions. It is useless to have a one-day session on safety without follow-up. There must be planned carry-over so that teaching staff will be aware of the need for safety at all times and make students aware of it. Planning of a school safety program, as outlined here, is recommended as an excellent topic for a professional development session.

Professional development will be required to encourage teachers to study these safety guidelines and to familiarize them with the available resources that are provided.

Appendices

Appendix A: Material Safety Data Sheets

[Graphic of MSDS sheets—pending copyright permission]

Teaching About MSDS

It is important students have practical experience interpreting samples of MSDSs. A sample activity and resource sheets follow, students with MSDS experience in a variety (information related to MSDSs can be found on the Internet by performing a search using keywords such as MSDS, WHMIS, safety, and science.

[WHMIS classification and symbols—pending copyright permission]

Appendix B: WHMIS Classifications and Symbols

[Classification symbols graphics—pending copyright permission]

Chemical Storage

There are several plans appropriate for storage as well as hazard ratings. The Biology Department will be using an WHMIS plan similar to the Fisher Scientific Chem Alert Safe Storage Plan and the J.T. Baker SAF-T-DATA Label System.

Basically, compatible chemicals are labelled with the same colour. Group these colours together in your chemical storage areas and follow the recommendations for proper storage as indicated in the following list of codes. Refer also to the chemical sections of the VWR Scientific, J.T. Baker, and Fisher Scientific catalogues for more information.

Chemical Storage Codes

Blue	**Health Hazard.** Material has the potential to be a severe health risk. Toxic if inhaled, ingested, or absorbed through the skin. Store in a secure area.
Red	**Flammable.** Material is flammable, extremely flammable or combustible. Material should be stored in a flammable-liquid storage cabinet or area. Keep away from strong oxidizers.
Yellow	**Reactive and Oxidizing Agents.** Material is highly reactive and may react violently with air, water, or other substances. The material is classified as one or more of the following: explosive, water reactive, strong oxidizer, or pyrophoric. Material should be stored separately. Keep away from flammable and combustible materials.
White	**Corrosive.** May harm skin, eyes, mucous membranes. Store in a corrosion-proof cabinet or area. Store away from red-, yellow-, and blue-coded chemicals/reagents.
Orange/Gray	**General Chemical Storage.** Material poses minimal risk while being stored. Presents no more than a moderate hazard (2 on a scale of 0–4).

Striped

Material Poses a Special Hazard. A careful review of all hazards related to the product should be conducted before a storage area is selected. A material could have a striped label because: it is incompatible with some materials that have the same color class and/or there are sufficient hazards to suggest that the material should have more than one storage class. When multiple storage classes are necessary, the label will be striped, and the risk believed to be the most critical for that material will determine the colour.

Storage Suggestions

Storage suggestions include the following:

- Avoid floor chemical storage (even temporarily).
- Avoid chemical storage on the top of the shelving unit.
- Avoid chemicals stored above eye level.
- Fasten shelf assemblies securely to a wall (avoid island shelf assemblies).
- Make shelving assemblies of wood.
- Provide lips on all shelves to prevent roll-off.
- Avoid metal, adjustable shelf supports or clips (fixed, wooden supports are preferred).
- Store both inorganic and organic acids in a dedicated acid cabinet with doors.
- Store nitric acid isolated from other chemicals.
- Store flammables in a dedicated metal cabinet with doors.
- Store extremely toxic poisons in a locked cabinet.

Acids

Store acid bottles in a corrosion-resistant plastic tray close to the floor. Concentrated nitric acid should be stored in a separate wooden compartment that has wooden dowel hinges and external locking attachments (no metal on inside surfaces). The cabinet must be vented to permit a continuous flow of air through it. Ideally, this cabinet should be in the chemical storage room.

Flammable Solvents

Flammable solvents must be stored in cool areas inside an approved (Underwriter Laboratories [UL] or Canadian Standards Association [CSA]) flammables cabinet. The cabinet must be vented to permit a continuous flow of air through it. If this is not possible, then it must be vented into a storage area that has continuous ventilation.

In general, a 120 L cabinet houses all the flammable solvents needed for most schools with more than 700 students. A 90 L cabinet is adequate for smaller schools. Many schools currently store too large a quantity of flammable solvents. In general, schools do not require more than 4 L of any one solvent in one year. It is recommended that a total of not more than 50 L of solvent be stored in any school.

Be certain the cabinet contains only flammable substances and absolutely no oxidizers (e.g., sodium peroxide*, a strong oxidizer will spontaneously react with solvents causing a fire/explosion hazard).

** Must not be present in school laboratories or storerooms.*

Toxic Substances

Toxic substances have the capacity to injure the body by direct chemical action. They include corrosive as well as poisonous materials.

Poisons should be stored above waist height, preferably in a locked cabinet.

Alternatives to a Separate Chemical Storage Room

While a separate room is preferable for chemical storage, the principles of proper chemical storage can be maintained without a separate room. If a science preparation room is used as the chemical storage room, it is appropriate to

- prevent the accumulation of harmful vapours by adequately and continuously venting to the exterior with an exhaust fan
- equip the room with a properly vented flammables cabinet to house all solvents and flammable materials
- store acid and basic (alkaline) solutions separately in closed and vented cabinets
- keep toxic chemicals (poisons) in a separate locked cupboard
- keep oxidizers and reducers on separate shelves as far from each other as possible
- store hydrolyzing (water reactive) solids in a separate area
- alphabetically store general miscellaneous chemicals if they are compatible

This is a challenging system to adequately maintain. Good housekeeping can be a problem when chemical storage is not housed in a separate room.

NOTE: When the science preparation room is used as the chemical storage room, it must not be used as a general teacher preparation area/working station (e.g., teachers are not to be present in the room other than when dealing with chemicals).

The disposal of biological materials, waste chemicals, and potentially hazardous materials is a necessary and common occurrence in school science laboratories. This section does not provide specific detailed information for the disposal of such materials, but indicates what resources the teacher or technician can consult to dispose of biological materials and waste chemicals properly.

Appendix C: Chemicals Used in Science Activities

The tables in this appendix contain lists of the chemicals commonly used in science activities in Nova Scotia (particularly at the high school level) and the hazards and handling precautions associated with their use. The codes used in the table to indicate toxicity, flammability, and reactivity are assigned in accordance with the Guidelines on Toxic and Hazardous Chemicals used in Educational Institutions, published by Health and Welfare Canada with some modification. These codes are explained below.

Toxicity

A toxic substance can interact chemically with the body to produce harm or injury. However, the severity of the injury depends upon several factors:

- the dosage
- the duration of frequency of exposure
- the route of exposure (e.g., inhalation, skin, mouth, and eyes)
- the chemical state of the substance

Several terms are used to report the level of toxcity of a substance.

- Lethal Dose Fifty (LD50)
  - The LD50 of a substance is the dose of the substance which causes death in half (50%) of a group of test animals exposed to the substance.
  - The LD50 is usually reported in mg/kg of body weight of the animal.
  - Species of animal tested, and route of exposure is included.
  - The lower the value of LD50, the more toxic the substance.
  - If the substance is a gas or vapour and the animal is exposed by inhalation, the Lethal Concentration Fifty (LC50) is often reported in ppm (parts per million)
- Toxic Dose Fifty (TD50)
  - The TD50 of a substance is the dose of the substance in milligrams of a substance per kilogram of body weight required to show a specific toxic effect in 50% of a group of test animals.
  - If the substance is a gas or vapour, the TC50 may be reported as the concentration of the substance in air showing a toxic effect in 50% of a group of test animals.

Although not given in the table below, exposure limits may be included in MSDS.

- Threshold Limit Values (TLV)—permissible exposure limits.
  - These are the maximum concentrations in air of a substance that most people may be exposed to by inhalation without suffering adverse effects.
  - The time weighted average TLV covers a person for 8 hours a day for 5 days a week.
  - The short term exposure limit TLV covers exposure to by inhalation for no longer than 15 minutes without harm if no more than 4 exposures a day occur.
  - The ceiling TLV is the maximum concentration that must not be exceeded even briefly.
  - The lower the values of TLV, the more dangerous the substance.

Rating	Hazard	Explanation
4	Extremely Dangerous	• oral LD50 value no higher thatn 50 mg/kg • dermal LD50 value no higher thatn 40 mg/kg • inhalation LC50 value less than 50 ppm over 4 hours • highly corrosive materials causing tissue damage after brief exposure to minimal amounts
3	Dangerous	• oral LD 50 value between 50 and 500 mg/kg • dermal LD 50 value between 40 and 200 mg/kg • inhalation LC 50 value between 50 and 200 ppm over 4 hours • corrosive materials causing tissue damage on splash contact
2	Caution	• oral LD 50 value between 500 and 2500mg/kg • dermal LD 50 between 500 and 2500 mg/kg • inhalation LC 50 value between 200 and 1000 ppm over 4 hours • corrosive materials causing tissue damage on extended contact (1 hour)
1	Low	• oral LD 50 value greater than 2500 mg/kg • dermal LD 50 value greater than 1000 mg/kg • inhalation LC 50 value greater than 1000 ppm over 4 hours • non-corrosive materials

Flammability

Flammability is defined as the lowest temperature at which a liquid gives off enough vapour to be ignited at the surface of the liquid. Flammable liquids have a flashpoint below 37.8° C while combustible liquids have a flashpoint between 37.8 and 93.3° C.

Rating	Hazard	Explanation
4	Extremely Dangerous	• flammable gases in air • liquids or solids with a flashpoint less than 0° C and boiling point less than 35°C • solids that can ignite spontaneously with air or moisture
3	Dangerous	• liquids or solids with a flashpoint between 0° C and 20° C
2	Caution	• liquids or solids with a flashpoint between 20° C and 50° C • solids which may be ignited readily by heat or flame
1	Low Hazard	• liquids or solids with flashpoints less than 100° C

Reactivity

Rating	Hazard	Explanation
4	Extremely Dangerous	• explode spontaneously • react vigorously with water • very strong oxidizing or reducing agents • monomers that may polymerize violently
3	Dangerous	• may explode if heated or detonated • reacts with water to produce heat or hazardous gases • strong oxidizing or reducing agents • deteriorate during storage
2	Caution	• oxidizing agents that react with combustible materials to produce explosive mixtures • undergo rapid exothermic reactions
1	Low Hazard	• materials with low reactivity

Storage

This section of table gives information about the storage hazard class to which each chemical belongs. The codes used are as follows:

- A—Acids (non-oxidizing)
- B—Aqueous solutions of bases
- D—Do not store - prepare or obtain as required
- F—Flammable and combustible materials
- G—Gases
- GI—General storage (inorganic chemicals)
- GO—General storage (organic chemicals)
- O—Oxidizing agents
- PD—Permanently sealed samples for display purposes
- R—Reducing agents
- S—Special storage

Disposal

This section of the table gives information about the disposal of each chemical. The codes used are as follows:

- A—Dilute aqueous solutions may be flushed down the drain with large amounts of water
- B—Solids in their original containers may be placed with garbage for disposal
- C—Package separately for disposal in a labelled container. Contact a disposal company or Department of the Environment for advice
- D—Place with non-halogenated organic solvents in a labelled container
- E—Place with halogentated organic solvents in a labelled container
- F—Permanently sealed samples for display purposes should be reused
- G—Return gas cylinders to supplier

CHEMICAL	Toxicity	Flammability	Reactivity	Storage	Disposal	COMMENTS
Acacia						• See gum arabic
Acetic acid Concentrated, glacial CH_3COOH	4	2	3	F	A, C	• Corrosive, flammable • Dilute solutions (such as vinegar) are less hazardous • Keep away from bases and oxidizing agents
Acetone, C_3H_6O	1	4	1	F	D	• Highly flammable, irritant • Keep away from oxidizing agents
Aluminum, Al (forms other than powder)	1	1	1	R	C, F	• Powdered form is highly reactive • Keep away from oxidizing agents, halogens and acids
Aluminum chloride, $AlCl_3$	2	1	2	GI	A, C	• Anhydrous compound is corrosive; reacts vigorously with water to produce corrosive and toxic acidic vapours • Hydrated compound is less hazardous
Aluminum sulfate, $Al_2(SO_4)_3$	1	1	1	GI	A, C	• Low hazard
Ammonia (ammonium hydroxide) concentrated, $NH_3(aq)$	3	1	3	B	C	• Corrosive; releases toxic ammonia gas • Keep away from acids, metals, halogens (reacts with halogens to produce highly explosive products)
Ammonium acetate NH_4CH_3COO	1	1	1	GI	A, B	• Low hazard • Keep away from strong oxidizing agents and acids
Ammonium chloride, NH_4Cl	2	2	2	GI	A, B	• Also called sal ammoniac • Causes skin and eye irritation • Keep away from acids, bases, silver and lead salts

CHEMICAL	Toxicity	Flammability	Reactivity	Storage	Disposal	COMMENTS
Ammonium dihydrogen phosphate, $NH_4H_2PO_4$	1	1	1	GI	A, B	• Also called monobasic ammonium phosphate • Low hazard
Ammonium hydrogen phosphate, NH_4HPO_4	1	1	1	GI	A, B	• Also called dibasic ammonium phosphate • Low hazard
Ammonium hydroxide						• See ammonia
Ammonium nitrate, NH_4NO_3	1	1	3	S	A, C	• Highly reactive & explosive if heated • Can explode at lower temperatures if contaminated • Keep away from oxidizing and reducing agents, metals and organic materials
Ammonium sulfate, $(NH_4)_2SO_4$	1	1	1	GI	C	• Low hazard
Antifreeze						• See antifreeze
Antimony, Sb (forms other than powder)	2	1	1	PD	C, F	• Toxic, flammable in powdered form • Keep away from oxidizing agents acids • Keep only as sealed sample for display
Baking soda						• See sodium hydrogen carbonate
Barium chloride, $BaCl_2$	3	1	1	GI	C	• Highly toxic • Keep away from acids, oxidizing agents
Barium nitrate, $Ba(NO_3)_2$	3	1	2	O	C	• Highly toxic, oxidizing agent • Keep away from reducing agents and organic and combustible materials
Basic Copper (II) carbonate						• See copper (II) carbonate, basic

CHEMICAL	Toxicity	Flammability	Reactivity	Storage	Disposal	COMMENTS
Benedict's solution	2	1	1	GI	C	• Mixture of copper (II) sulfate, sodium carbonate and sodium citrate • Basic and corrosive
Benzoic acid, C_6H_5COOH	2	1	1	GO	C	• Low hazard • Keep away from bases, oxidizing and reducing agents
Biuret reagent	2	1	1	GI	C	• Mixture of copper (II) sulfate and sodium hydroxide in water solution • Basic and corrosive
Bluestone						• See copper (II) sulfate
Bromothymol blue, C_2-$H_{28}Br_2O_5S$	1	1	1	GO	A	• Low hazard if dilute solutions are used
1-Butanol, C_4H_9OH	2	2	1	F	D	• Flammable • Irritant • Keep away from oxidizing agents, reactive metals
Calcium, Ca	3	2	3	R	C	• Flammable • Reacts vigorously with water to produce flammable hydrogen gas • Keep away from water, acids, oxidizing agents
Calcium carbonate, $CaCO_3$	1	1	1	GI	B	• Also called limestone, chalk, marble chips • Reacts with acid to generate carbon dioxide gas
Calcium chloride, $CaCl_2$	2	1	1	GI	A, B	• Irritant • Low hazard
Calcium hydroxide, $Ca(OH)_2$	1	1	1	GI, B	A, C	• Also called slaked lime • Saturated $Ca(OH)_2$ is limewater • Irritant

CHEMICAL	Toxicity	Flammability	Reactivity	Storage	Disposal	COMMENTS
Calcium nitrate, $Ca(NO_3)_2$	1	1	3	O	A, C	• Oxidizing agent • Keep away from reducing agents, organic materials and acids
Calcium oxide, CaO	3	1	3	GI	C	• Also called lime • Corrosive • Reacts vigorously with water • Keep away from water, acids
Calcium sulfate, $CaSO_4$	1	1	1	GI	B	• Also called gypsum, plaster • Low hazard • Keep away from aluminum powder
Carbon, C (forms other than powder)	1	1	1	GI	B	• Also called graphite, charcoal • Powdered form is more reactive and is a fire hazard • Keep away from oxidizing agents
Carbon dioxide, CO_2	1	1	1	G	G	• Solid form is known as dry ice —very cold; will cause frostbite; handle with tongs or gloves
Chalk						• See calcium carbonate
Charcoal						• See carbon
Chlorine, Cl_2 (aqueous)	2	1	2	O	C	• Handle with care • Keep away from reducing agents, metals, acids, and bases
Chromium, Cr (forms other than powder)	1	1	1	PD		• Powdered form is a fire hazard • Keep away from acids and oxidizing agents • Keep permanently sealed; only for display
Citric acid, C_6H_8O-	1	1	1	GO		• Low hazard • Keep away from acids, oxidizing and reducing agents
Cobalt (II) chloride, $CoCl_2$	2	1	1	GI	C,F	• Hexahydrate is less toxic than anhydrous

CHEMICAL	Toxicity	Flammability	Reactivity	Storage	Disposal	COMMENTS
Cobalt (II) nitrate, $Co(NO_3)_2$	2	1	3	O	A, B	• Oxidizing agent • Keep away from reducing agents and organic material
Copper, Cu (forms other than powder)	1	1	1	GI	C	• Powdered form is a fire hazard
Copper (II)carbonate,basic, $CuCO_3.Cu(OH)_2$	3	1	1	GI	C	• Also called cupric carbonate, basic copper (II) carbonate • Toxic • Reacts with acids to produce CO_2 gas
Copper (II) chloride, $CuCl_2$	3	1	1	GI	C, F	• Also called cupric chloride • Toxic
Copper (II) nitrate, $Cu(NO_3)_2$	2	1	3	O	C	• Also called cupric nitrate • Oxidizing agent • Keep away from reducing agents and organic material
Copper (II) oxide, CuO	2	1	1	GI	C	• Also called cupric oxide • Keep away from reducing agents, metals
Copper (II) sulfate, $CuSO_4$	2	1	1	GI	C	• Also called bluestone, cupric sulfate • Toxic; irritant • Available as pentahydrate or anhydrous
Cream of tartar						• See potassium hydrogen tartrate
Cupric carbonate						• See copper (II) carbonate
Cupric chloride						• See copper (II) chloride
Cupric nitrate						• See copper (II) nitrate
Cupric oxide						• See copper (II) oxide
Cupric sulfate						• See copper (II) sulfate
Dextrose						• See glucose
Dry ice						• See carbon dioxide

CHEMICAL	Toxicity	Flammability	Reactivity	Storage	Disposal	COMMENTS
Epsom salts						• See magnesium sulfate
Ethanol, C_2H_5OH	1	3	1	F	D	• Also called ethyl alcohol • Flammable • Denatured alcohol is poisonous • Keep away from oxidizing agents, metals and acids
Ethyl acetate, $CH_3COOC_2H_5$	1	4	1	F	D	• Highly flammable • Keep away from oxidizing agents
Ethyl alcohol						• See ethanol
Ethylene glycol, $C_2H_6O_2$	2	1	1	GO	D	• Also called antifreeze • Toxic if ingested • Keep away from oxidizing agents
Ferric chloride						• See iron (III) chloride
Ferric nitrate						• See iron (III) nitrate
Ferric oxide						• See iron (III) oxide
Ferrous sulfate						• Iron (II) sulfate
Gelatin	1	1	1	GO	A, B	• Low hazard
Germanium, Ge	1	1	1	PD	C, F	• Powdered form is flammable • Keep away from oxidizing agents • Keep permanently sealed; only for display
Glucose, $C_6H_{12}O_6$	1	1	1	GO	A, B	• Also called dextrose • Low hazard
Glycerin						• See glycerol
Glycerol, $C_3H_8O_3$	1	1	1	GO	A	• Also called glycerin • Low hazard • Keep away from oxidizing agents as violent reactions can occur
Graphite						• See carbon

CHEMICAL	Toxicity	Flammability	Reactivity	Storage	Disposal	COMMENTS
Gum Arabic	1	1	1	GO	C	• Also called acacia • Low hazard • Keep away from oxidizing agents
Gypsum						• See Calcium sulfate
Hydrochloric acid, concentrated, $HCl_{(aq)}$	3	1	3	A	A, C	• Also called muriatic acid • Corrosive • Keep away from bases, metals • Dilute solutions are less hazardous
Hydrogen Peroxide (3%) Peroxide (30%)	1 4	1 1	1 4	O O	A C	• Oxidizing agent • Do not store 30% solutions in schools • Keep away from reducing agents, organic materials and metals
Iodine	2	1	2	GI	C	• Corrosive • Irritating vapour • Keep away from metals, ammonia
Iron, Fe (forms other than powder)	1	1	1	GI	C	• Often in form of steel wool • Powdered form is a fire hazard • Keep away from oxidizing agents, acids, non-metals
Iron (III) chloride	2	1	1	GI	A, B	• Also called ferric chloride • Corrosive • Anhydrous compound reacts vigorously with water producing acidic vapours. • Keep away from oxidizing agents, alkali metals
Iron (III) nitrate, $Fe(NO_3)$	2	1	2	O	A, C	• Also called ferric nitrate • Oxidizing agent; irritant • Keep away from reducing agents, organic material
Iron (III) oxide, Fe_2O_3	1	1	1	GI	B	• Also called ferric oxide • Low hazard

CHEMICAL	Toxicity	Flammability	Reactivity	Storage	Disposal	COMMENTS
Iron (II) sulfate, $FeSO_4$	2	1	1	GI	C	• Also called ferrous sulfate • Low hazard
Isopropanol						• See 2-propanol
Lead, Pb (forms other than powder)	2	1	1	GI	C	• Powdered form is a fire hazard • Chronic exposure can cause poisoning
Lead (II) nitrate, $Pb(NO_3)_2$	2	1	3	O	C	• Oxidizing agent • Chronic exposure can cause poisoning
Lead (II) oxide, PbO_2	2	1	1	GI	C	• Chronic exposure can cause poisoning
Lime						• See calcium oxide
Limestone						• See calcium carbonate
Limewater						• See calcium hydroxide
Lithium, Li	4	4	4	R	C	• Flammable solid • Reacts with water forming flammable H_2 gas • Store under mineral oil • Keep away from air, water, oxidizing agents, acids
Lithium chloride, LiCl	2	1	1	GI	C	• Low hazard
Litmus	1	1	1	GO	A, B	• Low hazard
Lugol's Iodine Stain	2	1	1	GI	C	• This is a solution of iodine in water • Irritant • Keep away from metals, ammonia
Lye						• See sodium hydroxide
Magnesium, Mg (forms other than powder)	1	2	2	R	C	• Powdered form is highly reactive and flammable • Reacts with water to form flammable H_2 gas • Keep away from water, oxidizing agents, and water

CHEMICAL	Toxicity	Flammability	Reactivity	Storage	Disposal	COMMENTS
Magnesium sulfate, $MgSO_4$	1	1	1	GI	C	• Heptahydrate is called Epsom salts • Low hazard
Manganese dioxide						• See manganese (IV) oxide
Manganese (IV) oxide, MnO_2	2	1	2	S	C	• Also called manganese dioxide • Oxidizing agent • Keep away from other oxidizing agents, reducing agents, and organic material
Marble chips						• See calcium carbonate
Mercury, Hg (**NOTE:** Mercury is prohibited.)	3	1	1	PD	C,F	• Vapour highly toxic • Keep away from oxidizing agents, metals, ammonia • Keep permanently sealed; only for display
Methane, CH_4	1	4	1	G	G	• Flammable gas • Simple asphyxiant • Keep away from oxidizing agents
Methanol, CH_3OH	2	3	1	F	D	• Also called methyl alcohol; wood alcohol • Flammable • Toxic • Ingestion can cause blindness • Keep away from oxidizing agents and metals
Methyl alcohol						• See methanol
Methylene blue, $C_{16}H_{18}ClN_3S$	2	1	1	GO	A	• Dilute solutions are low hazard
Methylene chloride						• See dichloromethane
Mineral oil	1	1	1	GO	D	• Also called paraffin oil • Possibly carcinogenic if inhaled • Combustible • Keep away from oxidizing agents

CHEMICAL	Toxicity	Flammability	Reactivity	Storage	Disposal	COMMENTS
Muriatic acid						• See hydrochloric acid
Nickel, Ni (forms other than powder)	2	1	1	GI	C, F	• Powdered form is a fire hazard and possible carcinogen • Keep away from oxidizing agents
Nickel (II) chloride, $NiCl_2$	2	1	1	GI	C	• Toxic • Irritant
Nickel (II) nitrate, $Ni(NO_3)_2$	2	1	3	O	C	• Oxidizing agent • Toxic • Keep away from reducing agents, organic material
Nitric acid, concentrated, HNO_3	4	1	4	O	A, C	• Corrosive • Oxidizing agent • Dilute solutions are less hazardous but still require care • Keep away from reducing agents, organic aterials, metals
Nitrogen, N_2	1	1	1	G	G	• Simple asphyxiant • Liquid form is extremely cold; handle with insulated gloves
Oil of cloves	1	1	1	GO	D	• Low hazard
Paraffin oil						• See mineral oil
Phenolphthalein, $C_{20}H_{14}O_4$	2	1	1	GO	A, B	• Dilute solutions are low hazard
Phenyl 2-hydroxybenzoate, $C_{13}H_{10}O_3$	2	1	1	GO	C	• Also called salol, phenyl salicylate • Low hazard
Phenyl salicylate						• See phenyl 2-hydroxybenzoate
Phosphoric acid, concentrated, H_3PO_4	3	1	4	A	A,C	• Corrosive • Keep away from metals, bases

CHEMICAL	Toxicity	Flammability	Reactivity	Storage	Disposal	COMMENTS
Phosphorus, red, P_4	2	2	2	GI	C	• Flammable solid • Toxic • Keep away from oxidizing agents, metals, organic materials and bases
Plaster						• See calcium sulfate
Potassium bitartrate						• See potassium hydrogen tartrate
Potassium bromide, KBr	1	1	1	GI	A,B	• Low hazard
Potassium chlorate, $KClO_3$	2	1	4	O	C	• Oxidizing agent • May form explosive mixtures with combustible material • Keep away from reducing agents, organic material, metals, non-metals,
Potassium chloride, KCl	2	1	1	GI	A,B	• Low hazard
Potassium chromate, K_2CrO_4	2	1	4	O	C	• Oxidizing agent • Carcinogen • Keep away from reducing agents, organic material
Potassium dichromate, K_2Cr_2O-	3		2	O	C	• Oxidizing agent • Carcinogen • Keep away from reducing agents, organic material
Potassium hydrogen tartrate, $KHC_4H_4O_6$	1	1	1	GO	A,B	• Also called potassium bitartrate, cream of tartar • Low hazard
Potassium iodide, KI	2	1	1	GI	C	• Low hazard • Keep away from oxidizing agents
Potassium nitrate, KNO_3	2	1	3	O	A,C	• Pxidizing agent • Can form explosive mixtures with combustible material • Keep away from reducing agents and organic material

CHEMICAL	Toxicity	Flammability	Reactivity	Storage	Disposal	COMMENTS
Potassium permanganate, $KMnO_4$	2	1	3	O	C	• Oxidizing agent • Keep away from reducing agents, organic material, acids
Potassium thiocyanate, KSCN	2					• Toxic • Keep away from acids
Propane, C_3H_8	1	1	2	GI	C	• Flammable gas • Simple asphyxiant • Keep away from oxidizing agents
2-propanol, $(CH_3)_2CHOH$	2	4	1	G	G	• Also called isopropanol, rubbing alcohol • Flammable • Toxic if ingested • Keep away from oxidizing agents
Sal ammoniac		3	1	F	D	• See ammonium chloride
Salol						• See phenyl 2-hydroxybenzoate
Sand						• See silicon dioxide
Scarlet red						• See Sudan IV
Silica gel						• See silicon dioxide
Silicon, Si (forms other than powder)	1	2	2	PD	C,F	• Powdered form is flammable • Keep away from oxidizing agents • Keep permanently sealed; only for display
Silicon dioxide, SiO_2	1	1	1	GI	B	• Also called silicon (IV) oxide, silica gel, sand • Finely powdered form can cause lung damage if inhaled
Silicon (IV) oxide						• See silicon dioxide
Silver, Ag (forms other than powder)	1	1	1	GI	C,F	• Powdered form is a fire hazard • Toxic by inhalation

CHEMICAL	Toxicity	Flammability	Reactivity	Storage	Disposal	COMMENTS
Silver nitrate, $AgNO_3$	3	1	3	O	C	• Oxidizing agent • Toxic, corrosive • Keep away from reducing agents, organic material, ammonia
Slaked lime						• See calcium hydroxide
Sodium, Na	4	4	4	R	C	• Flammable solid • Reacts vigorously with water to produce flammable H_2 gas Can spontaneously ignite in moist air • Store under mineral oil away from air • Keep away from water, acids, oxidizing agents
Sodium acetate, CH_3COONa	1	1	1	GI	A,B	• Low hazard • Keep away from oxidizing agents
Sodium bicarbonate						• See sodium hydrogen carbonate
Sodium bisulfate						• See sodium hydrogen sulfate
Sodium bromide, NaBr	1	1	1	GI	A,B	• Low hazard
Sodium carbonate, Na_2CO_3	2	1	2	GI	A,C	• Also called washing soda • Corrosive and basic • Reacts vigorously with acids to form CO_2
Sodium chloride, NaCl	1	1	1	GI	A,B	• Low hazard
Sodium chromate, Na_2CrO_4	2	1	2	O	C	• Oxidizing agent • Carcinogen • Keep away from reducing agents and organic material
Sodium dihydrogen phosphate, NaH_2PO_4	1	1	1	GI	A,B	• Also called sodium phosphate, monobasic • Low hazard

CHEMICAL	Toxicity	Flammability	Reactivity	Storage	Disposal	COMMENTS
Sodium hydrogen carbonate, $NaHCO_3$	1	1	1	GI	A,B	• Also called sodium bicarbonate, baking soda • Low hazard • Reacts vigorously with acids to form CO_2
Sodium hydrogen phosphate, Na_2HPO_4	1	1	1	GI	A,B	• Also called sodium phosphate, dibasic • Low hazard
Sodium hydrogen sulfate, $NaHSO_4$	2	1	2	GI	A,C	• Also called sodium bisulfate • Acidic • Corrosive
Sodium hydroxide, NaOH	4	1	4	GI,B	A,C	• Also called lye • Highly corrosive • Keep away from acids, metals
Sodium iodide, NaI	1	1	1	GI	C	• Low hazard • Keep away from oxidizing agents
Sodium nitrate, $NaNO_3$	1	1	3	O	A,C	• Oxidizing agent • Can form explosive mixtures with combustible material • Keep away from reducing agents, organic materials and metals
Sodium phosphate, Na_3PO_4	2	1	1	GI	A, B	• Also called sodium phosphate, tribasic; trisodium phosphate, TSP • Basic, corrosive
Sodium phosphate, monobasic						• See sodium dihydrogen phosphate
Sodium phosphate, dibasic						• See sodium hydrogen phosphate
Sodium phosphate, tribasic						• See sodium phosphate
Sodium sulfate, Na_2SO_4	1	1	1	GI	A,B	• Low hazard

CHEMICAL	Toxicity	Flammability	Reactivity	Storage	Disposal	COMMENTS
Sodium sulfite, Na_2SO_3	2	1	2	GI	C	• Reducing agent • Reacts with acids to form toxic SO_2 gas • Keep away from oxidizing agents, acids
Sodium thiosulfate, $Na_2S_2O_3$	1	1	1	GI	A,B	• Low hazard • Reacts with acids to form toxic SO_2 gas
Stannous chloride						• See tin (II) chloride
Starch	1	1	1	GO	A,B	• Low hazard
Steel wool						• See iron
Strontium chloride, $SrCl_2$	2	1	1	GI	C	• Low hazard
Sucrose, $C_{12}H_{22}O_{11}$	1	1	1	GO	A,B	• Also called table sugar • Low hazard
Sulfur, S_8	1	2	1	GI	C	• Combustible solid • Keep away from oxidizing agents, reducing agents and metals
Sulfuric acid, concentrated, H_2SO_4	4	1	4	A	A,C	• Highly corrosive and reactive • Dilute solutions are less hazardous • Keep away from bases, reducing agents, organic material, metals, oxidizing agents
Table sugar						• See sucrose
Tartaric acid, $C_4H_6O_6$	1	1	1	GO	A,B	• Low hazard
Tin, Sn (forms other than powder)	1	1	1	GI	C	• Powdered form is a fire hazard
Tin (II) chloride, $SnCl_2$	2	1	2	GI	C	• Also called stannous chloride • Irritant • Keep away from reducing agents, oxidizing agents, metals
Toluidine blue, $C_{15}H_{16}ClN_3S$	2	1	1	GO	A	• Also called toluidine blue 0 • Dilute solutions are low hazard

CHEMICAL	Toxicity	Flammability	Reactivity	Storage	Disposal	COMMENTS
1,1,1-Trichloroethane	1	1	1	GO	E	• Irritant • Keep away from metals, bases
1,1,2-Trichlorotrifluoroethane, $C_2Cl_3F_3$	1	1	1	GO	E	• Keep away from metals
Washing soda						• See sodium carbonate
Wood alcohol						• See methanol
Zinc, Zn (forms other than powder)	1	2	2	R	C	• Reducing agent • Powdered form is reactive • Mixtures with combustible materials may ignite in contact with moist air • Keep away from non-metals, oxidizing agents, acids, organic materials
Zinc nitrate, $Zn(NO_3)_2$	1	2	3	O	A, C	• Oxidizing agent • Keep away from reducing agents, organic material, non-metals
Zinc sulfate, $ZnSO_4$	2	1	1	GI	A, C	• Low hazard

Appendix D: Chemical Suppliers

Boreal Laboratories Ltd.
399 Vansickle road
St. Catharine's ON L2S 3T4
Phone: (800) 387-9393
Fax: (800) 668-9106
www.boreal.com

Carolina Biological Supply Company
PO Box 6010
Burlington NC USA 27216-6010
Phone: (800) 334-5551
Fax: (800) 222-7112
www.carolina.com

Central Scientific Company (CENCO)
401 Vansickle Road
St. Catharine's ON L2S 3T6
Phone: (800) 268-4355 or (905) 984-8800
Fax: (905) 984-5118
www.cenconet.com

Fisher Scientific
PO Box 4508, Station E
Ottawa ON K1S 5A9
Phone: (800) 267-3556 or (613) 228-0542
Fax: (800) 463-2996 or (613) 226-7658
E-mail: help@fishersci.ca
www.fishersci.ca

Merlan Scientific
247 Armstrong Ave
Georgetown ON L7G 4X6
Phone: (800)387-2474
Fax: (905)877-0929
www.merlan.ca

Northwest Scientific Supply Company
301-3060 Cedar Hill Road
PO Box 6100, LCD1
Victoria BC V8P 5L4
Phone: (800) 663-5890 or (250) 592-2438
Fax: (800) 797-5773 or (250) 592-1341
E-mail: service@newscience.com
www.newscience.com

Sargent Welch-Cenco
403 Vansickle Road
St. Catharine's ON L2S 3Z7
Phone: (800) 727-4368
Fax: (800) 676-2540

Wards
397 Vansickle Road
St. Catharine's ON L2S 3T5
Phone: (800) 387-7822
Fax: (905) 984-5952
www.wardsci.com

Appendix E: Contact Lenses

The wearing of contact lenses in the lab has long been an item for discussion. The following information was taken from the Canadian Centre for Occupational Health and Safety (February 16, 2000) and Flinn Scientific, Inc. (1998)

What is the controversy about wearing contact lenses at work? Put as simply as possible, the problem is that, according to some people, contact lenses may complicate eye safety. The arguments against wearing contact lenses in the work environment are based on the following:

- dusts or chemicals can be trapped behind the lens and cause irritation or damage to the cornea or both;
- gases and vapours can cause irritation and excessive eye watering
- chemical splash may be more injurious when contact lenses are worn.

This increased risk is related to the removal of the lenses. If removal is delayed, first aid treatment may not be as effective and, in turn, the eye's exposure time to the chemical may be increased. However, the opposite may be true as well. Contact lenses may prevent some substances from reaching the eye, and thus minimize or even prevent an injury. Both situations have been documented. As a result, a wide range of opinions about the safety of contact lenses in the workplace has formed. More complete information is hard to find since occupational injury reporting systems do not typically include information about contact lens use.

The critical point to remember is that contact lenses are not intended to be used as protective devices. They are not a substitute for personal protective equipment (PPE)—if eye and face protection is required for certain work operations then all workers, including contact lens wearers, should wear the proper protective devices. Safe work conditions for all workers are only possible when basic occupational health and safety practices and procedures are followed.

Are there situations where it may be hazardous to wear contact lenses?

While these conditions may be hazardous to both contact lenses wearers and to people who do not, contact lens wearers should be aware that certain conditions may make it necessary to avoid wearing their lenses. Each situation should be carefully investigated. These situations may include:

- exposure to chemical fumes and vapours
- areas where potential for chemical splash exists

- areas where particulate matter or dust is in the atmosphere
- exposure to extremes of infrared rays
- intense heat
- dry atmosphere
- flying particles
- areas where caustic substances are handled, particularly those used or stored under pressure.

In workplaces with ultra-violet and infrared radiation sources, users of contact lenses require protection just as persons not wearing contact lenses do. Contact lens types absorb infrared radiation. This effect is potentially more harmful to the soft lens wearer as it could alter the water balance of the contact lens.

Are some hazards specific to soft contact lens wearers?

Soft lenses are made from a type of plastic that contains a large proportion of water. The soft lens adheres more tightly to the cornea and does not have as much fluid motion as the hard contact lens. For these reasons, some researchers think the soft lens offers some, but not total, protection against entrapment of foreign substances between the contact lens and the cornea.

The major risks for soft contact lens wearers are from chemical splashes and from hot, dry environments. Because of the high water content of the soft contact lens, some chemicals can pass through the lens and be held against the cornea by the lens itself.

Hot, dry environments can lead to problems because they can cause the tear layer (upon which the lens sits') to dehydrate . This situation results in eye discomfort.

Are some hazards specific for hard contact lens wearers?

Hard lenses are made from an impervious material. Increased risk may result if foreign substances, such as dust or small metal fragments, become trapped behind the contact lens. Since the hard contact lens floats on the tear film in front of the cornea (not in a fixed position), there may be an abrading action between the contact lens and the foreign substance that may result in injury to the cornea. Also, chemicals may become trapped behind the contact lens and held in place against the cornea. In dirty, dusty environments, the wearing of hard lenses may be more hazardous than soft contact lenses.

Who has responsibility for users of contact lenses?

The employer and the worker have responsibilities to ensure the safe use of contact lenses. Where contact lenses are worn, the following steps should be followed.

Employer

- Ensure that proper health and safety practices and procedures are followed.
- Provide training and education about eye hazards—particularly those specific to contact lens use—and training on the proper use of eye wash stations and procedures for rinsing the eyes.
- Clearly identify contact lens wearers. It is important that workers wearing contact lenses be clearly identified (especially for first aid).
- Have personnel available who are knowledgeable in the removal of contact lenses in case of an emergency.

Worker (Student)

- Take special care to keep contact lenses clean.
- Make sure your teacher knows that you are wearing contact lenses.
- Be alert for changes to environmental conditions that may be hazardous to you.
- Keep eye glasses available for unforseen circumstances.
- Wear personal protective equipment whenever required.
- Learn about eye hazards.

Appendix F: Safety for Science Students

- Maintain quiet, orderly behaviour during laboratory periods.
- Always be alert. Take care not to bump another student. Remain in your lab station while performing an experiment; an unattended experiment could result in an accident.
- Study the procedure of the experiment before performing it. If you are uncertain about the correct procedure to be follow, ask the teacher.
- Advise your teacher of any medical condition (contact lenses, allergies, respiratory problems, etc.) that might be aggravated by a particular experiment.
- Never attempt unauthorized experiments. No laboratory work may be carried on without the teacher's permission. Do not begin an experiment until directed to do so by the teacher.
- Stand up while doing an experiment unless directed otherwise by the teacher.
- Never wear expensive clothing when laboratory work is to be done.
- Avoid loose, bulky clothing, such as winter jackets, coats, etc., and dangling jewellery. Shorts, sandals, and bare feet are prohibited. Keep long hair tied back especially when an open flame is nearby.
- Never bring food or drink into the laboratory, and do not drink from lab glassware.
- The storage room is out of bounds to all students except when permission has been granted to individuals by the teacher.

Personal Protection

- Wear safety glasses or face shields when instructed to do so by your teacher.
- Know the location and correct operation of all safety equipment.
- The most common type of student injury is a burn caused by touching objects which have just been heated. Determine whether an object is hot by bringing the back of your hand up close.

Lab Practices

- Keep all work areas clean and tidy. Clean and wipe dry all desks, tables, or laboratory work areas at the end of each laboratory activity.
- Never carry hot equipment or dangerous chemicals through a crowd of students.
- Always waft odours towards your nose with your hand. Never breathe them directly.

- Wash your hands after handling any chemicals. Check with your teacher to see if gloves should be worn.
- Learn to light a Bunsen burner correctly. Keep your head back from the burner during the process.
- Never leave an almost colourless Bunsen burner flame unattended. If the burner is to be kept lit, shut off the air vent and decrease the gas supply to produce a flame resembling that of a candle.
- Use a water bath when heating corrosive liquids in a test tube.
- Use the proper type of tongs when handling hot crucibles or beakers. Crucibles must be held at the very end of crucible tongs. Place hot crucibles on a ceramic square or on the base of a rink stand. Do not allow hot objects to contact laboratory table top.
- When evaporating a solution to dryness in an evaporating dish, place a watch glass over the dish as protection from spattering.
- When removing an electric plug from its socket, pull the plug and not the cord. Report frayed cords to the teacher. Bare electrical wires can be extremely dangerous.

Chemicals

- Never taste chemicals. Use caution when handling all chemicals.
- Mercury is highly toxic. (**NOTE**: Mercury is prohibited.) Never handle it with your bare hands. Report any spilled or exposed mercury. It will ruin gold and silver jewellery on contact.
- Learn and use the correct method for pouring chemicals from reagent bottles. Hold the glass stopper above the hand and between the index and the middle finger so the same hand can grasp the bottle.
- When pouring chemicals from a beaker, use a stirring rod to direct the flow.
- Be especially careful with organic solvents, many of which are highly flammable and some of which are toxic.

Glassware

- Report sharp edges on prisms, mirrors, glass plates, metal objects, etc. to the teacher so they can be removed or repaired. Do not work with glass tubing that has jagged edges or edges which have not been fire polished.
- Check glass tubing to ensure that the flow of gas is not obstructed.
- Broken glassware should be placed in a container provided for that purpose. Be especially careful not to leave broken glass on benches or in sinks. A separate container should be used for insoluble residues. Never empty these into the sink.
- When heating a liquid or solid in a test tube, keep the tube moving in the flame. Hold the tube at an angle and heat the tube evenly on the sides and bottom. Point the tube's mouth away from others.

- Erlenmeyer flasks and beakers should be clamped to ring stands in addition to being supported on wire gauze and a ring.

Disposal

- Dispose of chemicals and specimens as instructed by the teacher.
- Flush sink drains thoroughly after using chemicals if they are disposed of in the sink.
- Never return unused solutions to stock containers or reagent bottles.

First Aid

- Rinse any skin burn immediately with lots of water. If an eye is involved, irrigate it without interruption for a minimum of 15 minutes. Refer to the Material Safety Data Sheet (MSDS) for the chemical involved for specific directions.
- Report all injuries to the teacher immediately, regardless how minor.

Spills

- Beware of what appears to be drops of water on laboratory benches. They may be corrosive liquid.
- Report all breakages and spilled chemicals to the teacher.

Appendix G: Regulations for Animal Experimentation

Experimental Studies

- All experiments must be carried out under the superivision of a competent teacher. It is the responsibility of the teacher to ensure that students have the necessary comprehension for the study to be undertaken.

- Students should not be allowed to take animals home for the purpose of carrying out experimental studies. All studies involving animals **must** take place in a suitable area in the school.

- All students carrying out projects involving vertebrate animals must adhere to the following guidelines:
  - No experimental procedures shall be attempted on a vertebrate animal that could subject it to pain or distinct discomfort or interfere with its health.
  - Students shall not perform surgery on vertebrate animals except for dissections of preserved specimens or specimens killed by a teacher (see Euthanasia).
  - Experimental procedures shall not involve the use of
    - microorganisms that can cause diseases in humans or animals
    - ionizing radiation
    - cancer-producing agents
    - drugs or chemicals at toxic levels
    - alcohol in any form
    - drugs that may produce pain
    - drugs known to produce adverse reactions, side effects, or capable of producing birth deformities
  - Experimental treatments should not include exercise until exhaustion, electric shock, or other distressing stimuli.
  - Behavioural studies should use only reward (positive reinforcement) and not punishment in training programs.
  - If egg embryos are subjected to experimental manipulations, the embryo must be destroyed humanely two days prior to hatching. If normal egg embryos are to be hatched, satisfactory humane provisions must be made for disposal of the young birds.

- The use of anaesthetic agents by students is not recommended and, in the case of some anaesthetics, is not permitted by law.

- Information on the care, housing, and management of individual species, as well as suitable experiments for use at the pre-university level, may be obtained from the Canadian Council on Animal Care, 315-350 Albert St, Ottawa ON K1R 1B1, Phone: (613)238-4031, Fax: (613)238-2837.

Youth Science Foundation Regulations for Animal Experimentation in Science Fairs

- Biological experimentation is essential for an understanding of life processes. Such studies should lead to a respect for all living things. Capable students, anxious to pursue a career in biological sciences, must receive the necessary encouragement and direction. All aspects of the project must be within the comprehensions and capabilities of the student undertaking the study.

- Lower orders, such as bacteria, fungi, protozoa, and insects can reveal much basic biological information. If experiments are to be conducted on living subjects for science fair projects, then only lower orders of life may be used.

- **Vertebrate animals are not to be used in experiments for projects or for science fairs, with the following exceptions:**
  - Observations or normal living patterns of wild animals in their free habitats or in zoological parks, gardens, or aquaria.
  - Observations or normal living patterns of pets, fish, or domestic animals.

- No living vertebrate animal shall be displayed in exhibits in science fairs.

- Cells such as red blood cells, other tissue cells, plasma, or serum purchased or acquired from biological supply houses or research facilities may be used in science fair projects. (NOTE: Guidelines from this document **prohibit** the use of mammalian cells, tissues, plasma, or serum.)

- Observational studies on only chicken egg embryos may be used in science fair projects. If normal egg embryos are to be hatched, satisfactory humane provisions must be made for disposal of the chicks. If such arrangements cannot be made, then the chicken embryos must be destroyed on the 19th day of incubation. No eggs capable of hatching may be exhibited in science fairs.

- All experiments shall be carried out under the **supervision** of a competent science teacher. It shall be the **responsibility** of the qualified science teacher to ensure the student has the necessary comprehension for the study to be undertaken. Whenever possible, specifically qualified experts in the field shall be consulted.

Euthanasia

The term *euthanasia* is used to describe the process whereby an animal is killed using recognized, acceptable humane techniques. By derivation, it means "easy death" and thus carries the explicit implication of a quiet, painless death without fear or anxiety.

The most important criterion of acceptance of a euthanasia method as a humane process is that it have an initial depressive action on the central nervous system (CNS) to ensure immediate insensitivity to pain.

It is important to recognize that some methods of euthanasia, which cannot be made aesthetically pleasant, such as decapitation or stunning with exsanguination (draining the blood), may nonetheless be humane in terms of the above criterion. This concept is important to keep in mind when deciding on the method of euthanasia to be used. The choice must be based on the sensibilities of the animal to be killed rather than the observer or operator, although the latter should not be disregarded.

Appendix H: Sample Permission Forms

Field Trip

Date

The Principal
School
Address
Postal Code

Dear Sir or Madam:

Re: _____(Name of Student)

I, the undersigned parent or guardian of the above named student, acknowledge receipt of your letter of [Date] containing details of the proposed field trip to [place] on [date].

I agree to the participation of my son/daughter in this field trip.

I understand this activity will be supervised by [sponsor teacher].

Yours truly,

Signature(s) of Parent(s) or Guardian(s)

NOTE: A form similar to this should be sent home with a detailed letter explaining the conditions of your field trip. The above form will be signed by the parent or guardian and returned to you before your students can participate on the field trip.

Outdoor Education Pre-Trip Authorization

School: _____ Principal: _____
Date(s) of Proposed Activity: _____
Destination: _____
Grade(s) Involved:_____ No. of Students: _____
Ratio of students to supervisors: _____

1. (a) Objective of Activity

_____
_____
_____

(b) Classroom Instruction Prior to Activity (Explain) Yes____ No ____

_____
_____
_____

(c) Classroom Follow-Up (Explain) Yes_____ No _____

_____
_____
_____

2. Personnel: Please list teacher in charge and names of volunteer parents, etc...

Person in charge: _____

	Parent	Teacher	Other
1.			
2.			
3.			
4.			
5.			

3. How will the activity be financed?

_____
_____
_____

4. Transportation

School Bus ❑ Other ❑ None Required ❑

5. Additional Information or Comments: (please include itinerary and activities—attached if required)

6. Are water/wilderness or high risk activities involved? Yes ❑ No ❑
Bus Trip Request Attached Yes ❑ No ❑

Signature of Person in Charge: _____

Date: _____

Approval

Principal: _____ Date: _____

This form is required for in-province and out-of province overnight trips. Out-of-province, overnight trips also require a pre-trip authorization form.

Curricular/Extra Curricular Education Permission Form

School: _____ Principal: _____
Date of Proposed Activity: _____ Destination: _____

1. Program/Trip Objectives:

_____

_____

_____

Detailed Account of Activities and Schedule (please list or attach itinerary)

_____

_____

_____

What Pre- and Post-Activities are Planned for this Trip?

_____

_____

_____

2. Personnel Involved:

	Boys	Girls	Total
Number of Students			
Average Age			
Grade Levels Involved			

Adults Involved

	Parent	Teacher	Other
1.			
2.			
3.			
4.			
5.			

Person in charge _____

Will these people be briefed on their responsibilities? Yes ❑ No ❑
Ratio: Adults/Students _____

3. Site/Accommodations

Where will the students be staying? _____
Have arrangements been confirmed in writing? Yes ❑ No ❑
Do students have appropriate insurance? Yes ❑ No ❑
What is the responsibility of the owners? _____
Will emergency measures be known to students re: fire drill, what to do in an emergency, etc.?
Yes ❑ No ❑

Are communication and emergency transportation available at all times? Yes ❑ No ❑
By whom? _____

4. Safety and Welfare

Have you provided adequate monitoring of all activities? Yes ❑ No ❑

Explain: _____
_____

What previous experience or planning have the students had to prepare them for this trip?

Explain: _____
_____

What previous experience has the school personnel/volunteers had in organizing and executing such a venture? _____
_____

Do you have first aid supplies available? Yes ❑ No ❑

Who is in charge of first aid? _____

What is their qualification? _____

Have all students completed their health form? Yes ❑ No ❑

Are there any water/wilderness or high risk activities involved? Yes ❑ No ❑
(If yes, complete form "C")

5. Parent Communication

Do you plan to hold a parent meeting to discuss the trip in detail? Yes ❑ No ❑

Date of meeting: _____

Will all students complete permission forms for special activities? Yes ❑ No ❑

Is there an emergency telephone number where students/parents can be reached? Yes ❑ No ❑

Will all students have a list of clothes, money, supplies, etc., required? Yes ❑ No ❑

6. Transportation

How will students be transported? Please check one and specify "other".

School ❑ Bus ❑ Train ❑ Air ❑ Other _____

Have arrangements been secured in writing? Yes ❑ No ❑_

If required, have you completed a School Bus Trip Requisition Form? Yes ❑ No ❑

7. Total Cost of Proposed Trip

Total Amount $_____

How will the trip be financed? _____

Date submitted for approval: _____

Principal's Signature: _____

Appendix I: Field Trips

While there is much concern about the safety of students engaged in field trips, there may be no greater risk here than in laboratories, provided classes are well managed and the trip is planned with safety in mind. One added concern is that such activities occur away from the school building where telephones and people with expertise who can offer assistance are normally visible.

When a field trip site includes water and high banks, these must be treated with respect; in some area, tides must be watched carefully. While Nova Scotia has few dangerous animals or insects, there are some that bite and sting. Although these are normally not very dangerous, they can cause great discomfort if appropriate first aid is not available. Toxic plants are few, but contact with them can certainly disrupt learning and make students very uncomfortable. A safety talk is necessary before each field trip, with specific dangers outlined and planned procedures for dealing with mishaps discussed.

Emergency procedures normally involve preparing for first aid for accidents, and planning for the possibility that students might become lost or isolated for some time because of inclement weather, unpredicted tides, or buses that do not arrive. The typical Boy Scout survival kit that is designed to deal with most emergencies of this type leads to a secure feeling on the part of leaders and could make the difference between a very unpleasant incident and a minor inconvenience.

Teachers and trip leaders must be aware of any health problems that students may have or any medication that students may be taking. This information should be obtained from the parents on an appropriate form along with their permission for the student to attend. There should be emergency numbers and contact people available to deal with any unfortunate incidents that may occur.

Careful planning is necessary to ensure that all essential supplies, such as first-aid kits, emergency food, shelter, and any other items necessary to deal with unforeseen happenings are available. Large first-aid kits containing material that is of no use to the first aider should be discouraged; they only get in the way. The basic first aid necessities, however, should be taken on all trips.

Supervision of trips is all important, and there should be a reasonable student-leader ratio. The ratio may vary, depending on the age of the student and the activities being undertaken. While an appropriate ratio for introductory canoeing might be 3:1, a ratio for a nature walk might be 25:1. First aiders among the group should be identified and their responsibilities known. Back-up people in the community should be notified if their services will be required.

Appendix J: Sample Storage Plan

[Under development]

Appendix K: Biohazardous Materials Safety

[Under development]

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Internet resources for MSDS

- http://www.ilpi.com/msds/index.html#Internet
- Manitoba Education and Training. http://www.edu.gov.mb.ca/ks4/docs/support/sci
- MSDS Online. http://msdsonline.com
- Sargent Welch Scientific Supply Company. http://www.sargentwelch.com/html/safetyck.html
- Saskatchewan Department of Education. http:/www.sasked.gov.sk.ca/docs/chemistry/pochem
- Vermont SIRI MSDS Collection. http://www.siri.org/msds/index
- VWR Scientific Products. www.vwrsp.com/safety/page.cgi?tmpl=main